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GERMAN WING TUNNELS AND APPARATUS
STUDY OF A STEAM TURBINE FOR AIRPLANES
THE LAFAYETTE FLYING CORPS
PRESENTATION OF THE GORDON BENNETT TROPHY

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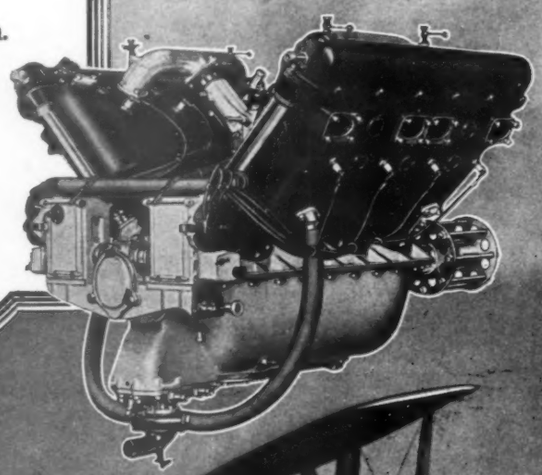

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Vol. IX NOVEMBER 8, 1920 No. 8

Belgium Takes Gordon Bennett Balloon Trophy

THE winning of the Gordon Bennett Cup by the Belgian balloon Belgica marks the first victory of that nation in this historic contest. Lieut. Ernest Demuyter and his aide, M. Labrisse, passed through several very severe atmospheric disturbances and in addition were handicapped by lack of knowledge of the geography of this country. They saw the American balloon Kansas City III a short time before it landed and decided that they must be going in the right direction. This displayed a sort of courage which is essential to true sporting events. Anyone who has ever been up in a free balloon knows the feeling of dependence on natural forces that comes from being played with by the wind. When one also does not know where he is going but keeps on he deserves all the reward he may receive.

Another side to the Belgian victory is the condition of that unfortunate country. It is an expensive matter to make an entry in a balloon race that is held in a foreign country and such participation is another indication that the country is resuming its business life after four years of war on its soil.

The United States will yield the cup more gracefully to the winners owing to the splendid impression made by the King of the Belgians when here last year. He is the great aeronautic leader among royalty and the use of his personal airplane for trips in Europe has made him honored and respected by all the aviation fraternity.

Dynamic Stability Calculation in Design

NO more powerful mathematical analysis was ever applied in aeronautics than Bryan's theory of small oscillations in the stability of an airplane. No mathematical theories have been as carefully worked out on an experimental basis both in the wind-tunnel and in full scale experiments. Scarcely any branch of aeronautical investigation has been so fruitful in the production of useful principles and rules for the airplane designer.

Nevertheless in a recent paper, Commander J. C. Hunsaker, one of the foremost students of stability, states that he has yet to see the design office where simultaneous equations of motion for an airplane are solved in process of design, and gives it as a definite opinion that empirical proportioning of surfaces, based on past experience is still the only safe method.

It would seem as if this were perfectly correct, and that at the present moment there is a distinct gap between theoretical stability and practical design. This gap may remain for a number of years.

We hope, however, that this will not discourage the students of theoretical stability. On the contrary, both mathematical work and experimentation should be multiplied, examples for actual machines multiplied, methods simplified, errors eliminated, until theory is ample and simple enough for practical needs.

The Election

WITH the change of administration that will come in March, important problems relating to aeronautics will come before a new personnel. The consensus of opinion in aeronautic gatherings is that Senator Harding and his appointees in the War and Navy Departments will be favorable to some form of a unified air service. It may take time to create an ideal aeronautic branch of the government and it is probable that the Army and Navy will retain a part of their present organization but that some central administrative department is probable is generally conceeded.

The retrenchment in expenditures that seems desirable in both War and Navy Departments will not affect aeronautic development work, if wise counsel prevails. A far seeing policy which will recognize the power of aircraft in warfare and weigh the results possible from the same expenditure in this form of fighting equipment as compared with other arms will inevitably reach the conclusion that air power will be the most economical of all offensive and defensive programs.

The new administration has unparalleled opportunities in the development of our air power. It will be free from all the war time investigations and their unpleasant reflections. It can make the United States preeminent in the air by giving this arm of our national defense the consideration that it deserves.

Six Cylinder Engines

THERE is a well defined tendency in automobile construction to discard twelve cylinder and eight cylinder engines in favor of six cylinder engines. We should not be surprised if the same tendency appeared in airplane construction, where as a matter of fact, the field already lies mainly between the twelve and six cylinder engines. Granted always that the twelve will be more smooth running, and that for similar powers the cylinders will be smaller—somewhat of an engineering advantage—the six cylinder really has a great deal on its side.

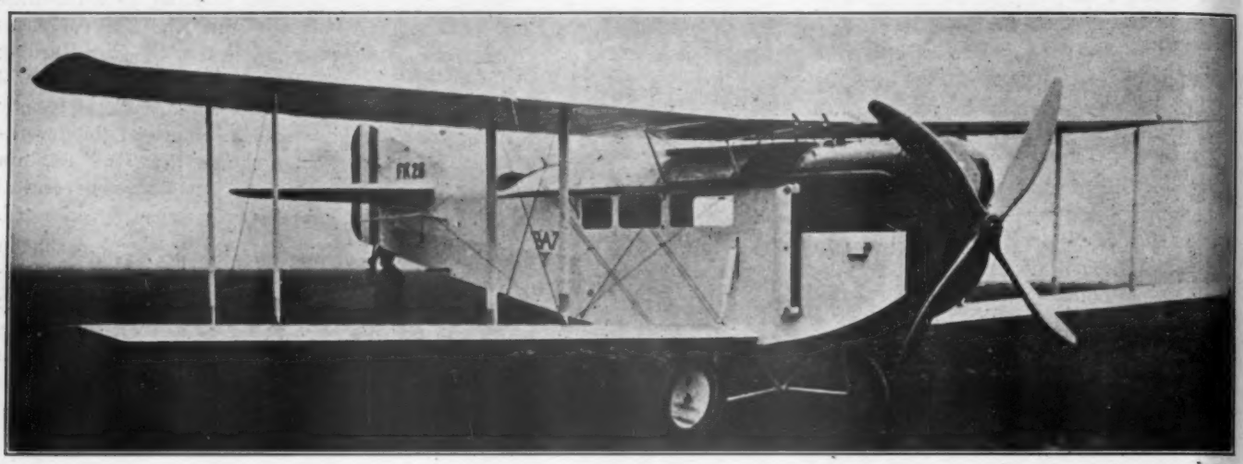
It will always lend itself to a simpler installation with fewer gasoline and water lines. It is certainly more accessible, with no bothersome space in the V to get at. If mounted on the wings of a twin-engined machine, it is the only type of engine in which there is any possibility of a mechanic climbing from the fuselage doing repair work at all easily. The six cylinder engine more readily adapts itself to mounting on the wings, and it can be hoisted out more easily from the engine compartment of a single engined airplane. Foreign experimentation indicates that cylinders of 11 by 8 can be employed in airplane engine construction, and several six cylinder engines of over 400 hp. are on the market. No engines made a better showing during the war than the German vertical sixes. It would seem as if the large vertical six deserves the most careful consideration.

A Figure of Merit for Airplanes

By Donald W. McIlhiney

Aviation and Aircraft Journal will be glad to receive from its readers any discussion of a Figure of Merit that they have developed. The subject is one that should be given attention by all aeronautical engineers and airplane constructors.—Ed.

Since the armistice several excellent commercial airplane designs have appeared. These machines have widely different characteristics. It would be of value to be able to rate them according to some established and understandable standard. To be of any use, such a standard should include the essential elements of a machine's worth and yet not contain any indeterminate or unknown factors.



B.A.T. Commercial Mark II

A term known as a "Figure of Merit" has been employed in rating galvanometers for upwards of two generations. The United States Bureau of Standards has evolved one for use in expressing the merits of radiator types. A figure of merit is a number which is derived by taking all the factors concerning the article in question in some form of mathematical expression.

The Situation Abroad

Some efforts have been made in Europe toward establishing a figure of merit. The purpose has been different in each country and some of the results may be of interest.

In the recent government competitions in England, a figure was derived that gave a rating to the transport-economy of the machine in question. This figure was obtained by dividing the useful load by the number of gallons of fuel consumed during a three and a half hour test. This figure showed the number of pounds one gallon of fuel would transport in that period. It was confined to a special case and required a test for its determination. It could not be accepted as universal for the above reason nor was it intended as such by the judges.

The nearest approach to a figure of merit in France is the factor employed in determining the amount of air transport subsidies. This again is obviously a special case and includes factors that must be determined by actual operation, such as, the number of trips completed in a month. While this figure was intended to be universal it was not intended as a rating of the machines employed.

The Germans have evolved two figures of merit which they are using to show the alleged superiority of their machines over foreign designs. These figures are: $\frac{\text{Total weight} \times \text{speed}}{\text{Propulsive power}} = A$, and $\frac{\text{Total load} \times \text{speed}}{\text{Propulsive power}} = B$. While each of these figures gives an indication of the usefulness of a machine, they are not a fair statement of the machines' value. Of the two the figure B is to be preferred as it is more nearly related to the income brought in by the machine. It is not strictly related, however, as the total load includes the fuel and the crew, neither of which are revenue earners. The various forms of efficiency affecting the performance are very indirectly contained in the figures; a very large machine, though quite inefficient, might appear better than an efficient small machine.

A concrete example will demonstrate this unfairness. The figure B for the Rumpler 5-A-2 limousine, a converted army observation two-seater, is about 647 and for the B.A.T. Commercial Mark II, 586. Using the figure of merit proposed below, the Rumpler is rated at about 1608 and the B.A.T. at 3043. This is more in keeping with the respective qualities of these two machines. The ratio of pay load to total weight in the Rumpler is 14 per cent and in the B.A.T. it is 17.75 per cent. The speed range of the Rumpler is 2.08 and of the B.A.T. 2.24. The range of the Rumpler is 466 mi. while the range of the B.A.T. is 600 mi. The maximum speed of the Rumpler is only 94 m.p.h. and the same figure for the other machine is 124 m.p.h. Surely the German figure fails to show this superiority in almost every point by a ratio of 647 to 586. The ratio of the proposed figure of merit, 1608 to 3043, would seem to be nearer the truth.

Factors to Be Considered

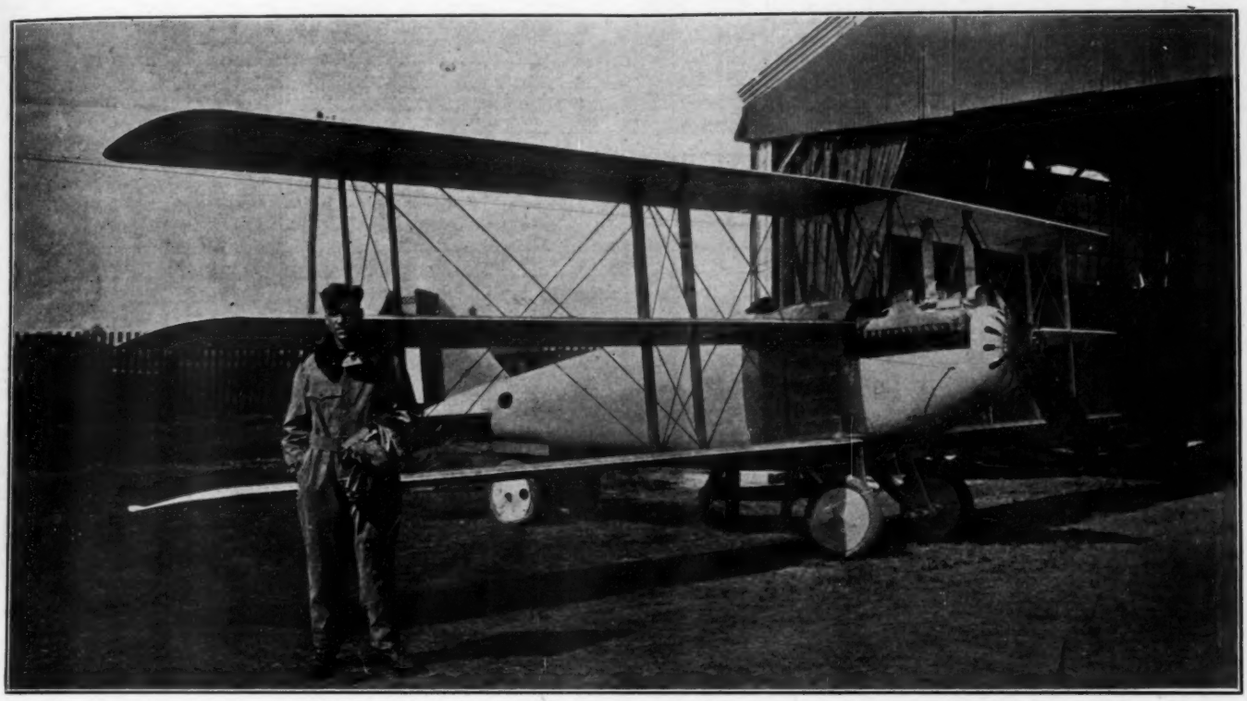
In developing a figure of merit, only those factors which have a direct bearing on the usefulness or value of the machine, and can be easily obtained from published descriptions of the machines, should be considered. Those factors which require a special test or consultation with the manufacturer must be omitted, as their use would entail so much effort as to not only deter people from using it but greatly limit the number of machines that could be rated. In the following an attempt will be made to analyze and then select the factors that are desirable in this connection.

Structural Efficiency. This factor has always been a bone of contention. In the early days predictions were freely made that the ratio of useful load to total weight would shrink to zero as airplanes increased in size. Today designers proudly point to high ratios as their best achievement. As far as usefulness goes, on the other hand, the ratio of pay load to total

weight is far more important. In commercial designs the pay load can usually be easily determined. The weight of one passenger with baggage can be taken at 200 lb. as a fair approximation.

Speed Range. This is a measure of the aerodynamic efficiency of the machine and is a factor to be desired, for the greater the speed range, the better the chances of getting out of a tight place. This has been recognized and in a recent French competition a ratio of 5.98:1 was attained under test conditions.

Reliability. This is the most important factor in the mind of the lay public today. Unfortunately it is not easily determined. If figures of operation for a period of time be taken, it will be found that the same type in the hands of one group will be much more reliable than some sister ships looked after by another group. This is another example of the effect of the personal equation. On the other hand, a figure of merit is a working rating and to be of use should be known when the machine has finished its acceptance tests. A final rating could undoubtedly be given after a year or so of operation,



CURTISS WASP 18-T

Power Utilization. This is a measure of the power plant efficiency. The greater the load carried by one horsepower, the more economical the machine will be, other things being equal. And economy should be the object of all connected in any way with air transport.

Ton-Miles. This is a standard criterion of any form of transport. At the present stage of aircraft development it is more convenient to speak of pound-miles, as machines carrying as much as one ton of pay load are rather rare. However, in the final form of the figure of merit, both pay load and total weight may be expressed in tons without affecting the amount of the result.

Time Saving. The saving of time is the main "selling point" of air transport and will remain so for many years. The time is coming nevertheless, when air transport may be actually cheaper as well as a great deal faster than any form yet evolved. This is because the equipment necessary in addition to the vehicles is far smaller.

Fuel Economy. This factor depends too much on uncontrollable conditions to include it. In identical machines with different crews one of the lot will have a smaller fuel consumption than the others due to better skill in adjusting and operating possessed by its crew. The fuel economy is reflected in the pay load because the smaller the amount of fuel required to go a given distance, the greater the pay load that may be carried. It will also be reflected in the pound-miles. However, one pound less fuel and one more pound of pay load does not mean that the pound-miles will remain unaltered.

Another uncontrollable factor is the character of the fuel. The fuel is not only different in different parts of the country but two owners in the same locality may use different fuels in the same engine. The variation between "high test gas" and "motor spirit" is an example. Fuel economy, therefore, can not be included in a mathematical expression until some standards are universally adopted.

but the machine will be nearly obsolescent when it is determined.

Comfort, etc. These questions are entirely empirical and it would be hard to find two people who will agree on the relative merits of various machines in this respect. It would seem that they can not be expressed mathematically without some arbitrary scale.

First Cost. The cost of a machine is often the deciding point with a user but it is difficult to express it fairly for all machines. It would be obviously unfair to compare the cost of a four-passenger machine with a two-ton freighter. The only way would be to consider the cost according to the type of machine but types are not yet standardized and when classes are established, machines on the border line of two classes would be unfairly treated. Moreover few manufacturers advertise their prices.

Summary of Factors

From the analysis given above the following factors have been selected and the reason for the form of the expression is given where required.

$$\text{Speed range} = \frac{V_{90\text{ per cent max}}}{V_{\text{landing}}}$$

$V_{90\text{ per cent max}}$ is used instead of the maximum speed as the maximum should only be employed in emergencies.

$$\text{Structural efficiency} = \frac{\text{Pay load}}{\text{Total weight}}$$

Pay load is used instead of useful load because a commercial machine is a revenue producer and the greater the structural efficiency as given, the greater the possible return from the investment in the machine.

Power utilization = Lb./hp.

Pound-miles = Pay Load $\times$ Range

Time Saving = $V_{90\text{ per cent max}}$ $\times$ Range

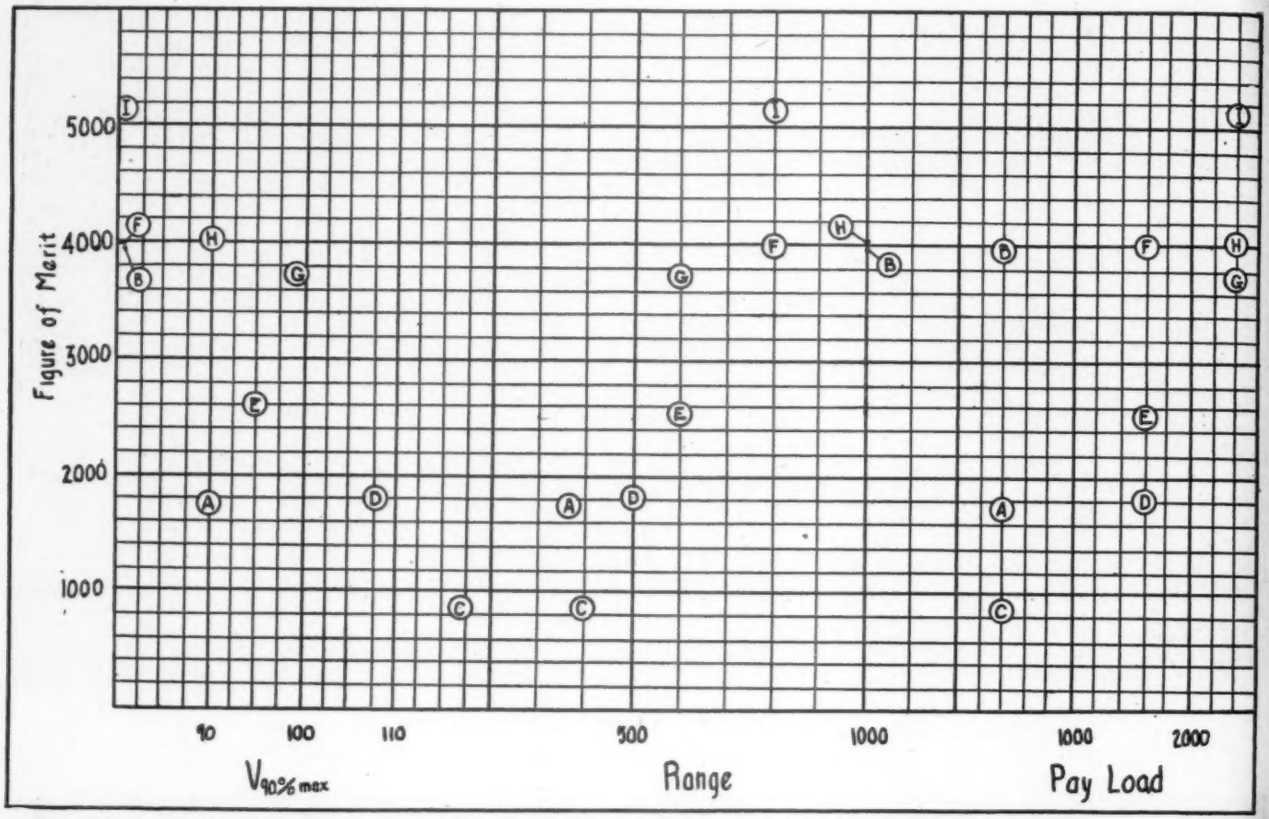
This is perhaps not the most convenient way of expressing such an abstract quantity but is required to simplify the final equation. The greater the above quantity the greater the time saving.

It might be thought better to give each of the above factors their full value instead of weighting them according to some scale of relative importance. In the opinion of the present writer no scale is really necessary and those that believe it is will find difficulty in obtaining unanimity as to the scale to be employed.

difference is in the performance and in evaluating the pay load. In considering military machines take V_{max} instead of $V_{90 \text{ per cent max.}}$ The pay load is all the useful load minus fuel and oil as the function of a military machine is to transport its crew to a certain spot along with the necessary gear for the mission.

To include all the points of performance, the figure of merit obtained should be multiplied by the following coefficient:

Climb (ft./min.) $\times$ service ceiling



THE FIGURE OF MERIT PLOTTED AGAINST THREE PRINCIPAL CHARACTERISTICS. THE GROUPING BROUGHT ABOUT BY THIS IS EVIDENT AND INDICATES THE MANNER OF USING THE FIGURE OF MERIT

Figure of Merit

$$\frac{\text{Lb./hp.} \times V_{90 \text{ per cent max}} \times \text{pay load} \times \text{range}}{V_{\text{landing}} \times \text{total weight}} = \text{Figure of merit}$$

It is readily seen from the form of the equation that the figure of merit is directly proportional to lb./hp., $V_{90 \text{ per cent max}}$, pay load, and range. It is inversely proportional to V_{landing} and total weight. It can also be seen that the figure of merit is directly proportional to the speed range, the structural efficiency and the pound-miles. Or, in other words, the better the characteristics of the machine, the larger the figure of merit.

The pay load is the only factor that can be misconstrued in dealing with civil machines. Where the machine carries a load of goods or mail, there is no chance of confusion, but when passengers are carried on an airway, care must be taken that the crew is not included in the pay load. Many machines are described as carrying a certain number of people including the crew. For example; a ten-seater may be only an eight passenger machine. If the machine is used for sport flying all the occupants may be included in the pay load. In brief, the pay load is that load from which revenue or pleasure is normally derived.

The Figure of Merit Applied to Military Machines

In military work there are different standards of desirability than the ones already stated for civil machines. The principal

and divided by 10^7 to make the final figure of the same order as the civil figures.

Civil and Military Figures of Merit Compared

To show the working of the calculation, the following figures of merit for the Curtiss Wasp Triplane (18-T) are given, taken as a military machine:

$$\frac{7.26 \times 163 \times 631 \times 550}{58 \times 2901} \times \frac{1500 \times 29{,}000}{10^7} = 6699$$

Taken as a civil machine with no alterations:

$$\frac{7.26 \times 147 \times 400 \times 550}{58 \times 2901} = 1395$$

With a cabin built in place of the rear cockpit, the data and consequent figure of merit would probably be somewhat as follows:

$$\frac{7.26 \times 140 \times 600 \times 550}{58 \times 2901} = 1993$$

The assumption being that the cabin holds three passengers with the crew of one in the same pilot's cockpit. The conversion reduces the speed as indicated but makes no other substantial change.

The various figures show that a very fine military machine

does not necessarily make a good transport machine. The high normal speed of the converted machine would give the machine great value for special work such as hurry calls at long distances or as a private conveyance with a hired pilot, but the machine would be a fairly costly transport machine.

Using the Figure of Merit

In as complex a vehicle as an airplane there are so many different uses and requirements that must be considered in making a selection, that no figure of merit, it is believed, could immediately point out the machine for the purpose. The figure of merit must be considered in conjunction with some specific requirement, such as range, pay load, high speed, etc. Some fictitious machines are given in the following table which will serve to illustrate this point:

Machine	V_{max} m.p.h.	V_{80} per cent max m.p.h.	$V_{landing}$ m.p.h.	Pay Load lb.	Range mi.	Total Weight lb.	Hp.	lb./hp.	Figure of Merit
A ..	100	90	42	400	370	4,000	180	22.2	1760
B ..	90	81	37	400	1000	5,400	220	24.5	3973
C ..	130	117	54	400	400	5,650	400	14.1	865
D ..	120	108	50	1600	500	16,880	960	17.6	1802
E ..	105	95	45	1600	600	17,360	800	21.7	2533
F ..	90	81	40	1600	800	16,600	650	25.6	3997
G ..	110	99	49	2400	600	16,050	775	20.7	3752
H ..	100	90	44	2400	1000	28,950	1200	24.1	4087
I ..	90	81	38	2400	800	21,000	810	26.0	5165

It can readily be seen from the table that there are three groups of machines according to pay load. The crew in the small machines was taken as one, in the medium sized machines as two and in the large machines there is assumed to be a crew of three. The structural efficiencies and speed ranges can be determined from the figures and it will be found that none of them are unreasonable. These machines are entirely fictitious and are not existing machines presented incognito. In the examples previously quoted, the Rumpler is a German effort, the B.A.T. Co. is an English concern and the merits of the Wasp are now generally accepted while no attempt has been made to convert it to civil use.

In the accompanying diagram the figures of merit of the various machines have been plotted against three of the principal factors. As an illustration, if these machines represented the available types and the conditions of service required a minimum normal speed of 100 m.p.h., the field is narrowed to two machines, *D* and *C*. *D*, having the higher figure of merit, is the machine for the job. Where a range of 1,000 mi. is required, as between New York and Chicago, machines *B* and *H* are available with *H* the choice unless the pay load is insufficient to fill it. Range is the only independent factor and it has been shown by others that the greater the range the greater the odds in favor of air transport as opposed to ground transport. Other examples present themselves readily from the diagram and so need not be enumerated. It is only necessary to repeat that the figure of merit must be considered in connection with some other quality.

Summary

The whole question of a figure of merit revolves on the point of usefulness. If a figure of merit will make what we have, more useful or promise improvements in the future, there is a place for it in aeronautical endeavor. A figure of merit gives a rating to completed or even contemplated designs and so throws the whole field into perspective and allows the semi-trained purchaser some basis for his choice. The effect of the use of a figure of merit would be to discard those designs which accomplish their ends in an inefficient and uneconomical manner and would also lead designers to produce only those designs which would receive good ratings. It would thus make what we have today more useful by permitting only the strong to survive, and would promise improvements in the future by warning designers that an impartial and unvarying judge would pass on their work.

It is hoped that the figure of merit worked out in this article is sufficiently comprehensive to accomplish some of the above results. Some sort of a measure of overall worth is needed in order to standardize and direct public opinion. A figure of merit that contains all the essentials in the correct proportions would not work harm to any conscientious manufacturer; the ones to be hit would be the ones who offer inefficient machines.

The Stout Bat-Wing Limousine

Underwood & Underwood

This very interesting design is the latest product of the Stout Engineering Laboratories. It embodies the much talked of bat-wing construction and is powered by a 200 hp. Packard engine. The cabin seats three people. The pilot has a wide range of vision through the side doors and over the engine where the wing is cut out. The wing covering is plywood.

This model is the fore-runner of a series of military and commercial machines that W. B. Stout has in mind. A contract has been made with the Navy to supply six torpedo planes with two Liberty engines. The principal idea behind all these designs is to have every exposed part of the machine a lifting surface.

German Wind Tunnels and Apparatus*

By Edward P. Warner

It is appropriate that any discussion of aerodynamical work in Germany should begin with Goettingen and with Prof. Prandtl, where the first serious work of the kind was undertaken, before the war, and where the most extensive and interesting results have been obtained both in respect of wind tunnel testing and of purely mathematical investigations.

The Goettingen Wind Tunnels

There are, at the present time, two wind tunnels at the Goettingen laboratory, one being the original 1-meter tunnel of pre-war days, but moved into a new building; the other a newer installation 2 meters in diameter. During the war both tunnels were kept in service, but that is now impossible with the present shortage of funds and of employes, and the small tunnel is now seldom used. The larger one is built on essentially the same principle, but with substantial modifications in detail. In the first place, the plane of the closed circuit which the air follows has been turned from the horizontal to the vertical, the return passage being under ground. The whole tunnel, except the portion immediately around and adjacent to the test section, is made of concrete, so there is no question of air-tightness.

The section, 2 meters in diameter at the throat, expands in each direction to a diameter of 4.5 meters before the first turns are reached, and this size is maintained all the way around the return, making an area ratio of 5 to 1. The air is still guided around the turns by means of vanes, but these vanes are no longer adjustable in position or inclination to secure regularity of flow, such adjustment having been found unnecessary, nor are they now made in honey comb form. They are cast in the concrete, are of crescent form with a maximum thickness of about one-fifteenth of the chord, which is about 18 in., and are spaced approximatey 8 inches apart. The vanes are not arranged to cause all the particles of air to swing about a common center, as might perhaps be expected, but are all of the same size and all curved to the same radius, so that the outside boundary of the tunnel comes to a corner and the section is increased at the turns.

The stream is not enclosed at its throat, although a tube is available which can be put into place to partially restrain the flow if desired. The stream being enclosed at every other point of its travel, the pressure at the throat is the atmospheric pressure in the free air, while that in the return passage is raised above atmospheric, and no experimental chamber of air-lock is necessary.

The only means provided for regularizing the flow is a honeycomb placed in the large section of the tunnel, before the contraction to the throat begins. This honeycomb is made up of metal plates separated by corrugated strips, so that the cells have a rather eccentric form, approximately semi-circular. The mean effective radius of these cells in about ⅜ in., the length 8 in. Prof. Prandtl lays great stress on the value of placing the honeycomb where he has it, before the entrance cone, in order to avoid turbulence and minute eddies which he believes are produced by a honeycomb of the ordinary type. Admittedly there is some loss in regularity of flow as ordinarily judged when the honeycomb is moved farther away from the throat, yet the regularity at Goettingen seems to be very good. Incidentally, Capt. Toussaint is quite convinced of the merits of Prandtl's placing of the honeycomb and preparing to adopt a similar disposition at St. Cyr, and the matter was also receiving serious consideration at the N.P.L.

The current is produced by a four-bladed wooden propeller of ordinary type, driven by a 300 hp. electric motor. The maximum wind speed obtainable is 50 m. per sec., which, if the motor is working at rated power without overload, corresponds to an energy factor of 1.36 (a result not in any way remarkable). The motor is outside the tunnel and drives the propeller by a shaft passing through the wall at the turn.

The forces and moments on the models are ultimately weighed on ordinary platform balances, the only special apparatus being that which transmits the forces from the roof of the tunnel, or, more properly from the platform erected above the air-stream, down to the balances which are placed conveniently for the observers standing on the floor. The apparatus is primarily of interest in that the support in all cases is solely by wires, no spindles being used under any conditions. Furthermore the measurements of lift and drag are direct and entirely separate, no moments entering in until the balances are reached.

In the case of an airship model or other similar streamline body, the support is by five wires. Four of these are arranged in two pairs, the two members of a pair attaching to the model at the same point and then diverging, their plane being perpendicular to the direction of the wind. One pair is attached about a quarter of the way back from the nose of the model, the other about three-fifths of the way back. The fifth wire is attached at the same point as the forward pair, and runs forward exactly parallel to the wind direction. At a point about two ft. forward of the nose of the airship this wire terminates in a small ring to which are also fixed two other wires, one running vertically upward and the other obliquely downward and forward to the floor at the end of the entrance cone. This diagonal wire is simply fixed to a screw-eye in the floor, while the vertical wire is attached to a crank on a rocking beam, another offset crank on which bears against a vertical rod running down to the pan of the platform balance. The pull in the vertical wire can thus be weighed directly, and, knowing the directions of the other two wires attached to the ring, the pull in the horizontal wire, which is equal to the drag of the model, can be calculated.

As a matter of fact, it is believed, that the oblique wire runs off at just 45 deg., so that the balance reads the drag directly with ordinary weights. The total pull in each pair of vertical wires is similarly measured, the two members of a pair being attached to two cranks on a single beam so that the total is obtained directly. The lift on the model is then equal to the sum of the two readings (correction having been made for the tensions due to the weight of the model), and the pitching moment can be directly calculated from this difference. The angle of attack is adjusted by raising and lowering the rear beam and wires.

Of course, as the angle is changed the horizontal distance between the points of attachment of the two sets of wires changes, and, if the rear beam were raised or lowered vertically, it would be impossible for both pairs of wires to remain truly vertical. The two beams are therefore connected together by a link forming, with the two sets of wires and the line connecting their points of attachment in the model, a parallelogram. The five wires suffice to restrain the model from all motions except those in roll, and these are resisted by its own weight. As an additional safeguard against rolling, a wire may be attached to the lower surface of the model and run downward and backward over a pulley, a heavy weight being hung at its free end, thus introducing a constant correction to both lift and drag. Despite this precaution, the model of an airship which was being tested at the laboratory several times started oscillating badly and it was necessary to reach into the current with a stick and steady the model just before the final balance readings were taken.

In the case of wings, the same balances are used and the method is essentially the same, but there are differences in details of attachment. The model is made with four hooks cut from thin sheet metal mounted on it, three of these hooks being distributed along the leading edge and the fourth carried by a rod which projects about one and a half chord lengths to the rear of the trailing edge. The two hooks mounted near the tips on the leading edge carry wires running vertically to the forward lift beam; the center hook carries the wire which runs forward to measure the drag, and the rear hook, on the rod, forms the point of attachment for two wires running off in a V to the rear lift beam. The model is then definitely fixed except in regard to yaw. Should any particular model

* N. A. C. A. Report.

show a tendency to oscillate in that respect it can easily be checked by running two wires from each corner of the leading edge to the forward lift beam, the whole set of four then appearing from the front as a W. This is to be done as a regular practice at the Zeppelin laboratory.

The spindle correction for wings is obtained by substituting for the model a T made of two pieces of stream-line wire about 5/8 in. x 3/16 in. in section. The cross-arm of the T has a length equal to the span of the aerofoil, the shank a length equal to the distance between the leading edge of the aerofoil and the rear point of attachment used for the determination of pitching moments. This T is hung up in exactly the same manner as the model, and the drag measured. The resistance of the stream-line wires being known with fair accuracy by computation and by previous experiment, the effect of the supporting wires can be determined at once by subtraction. In the case of an airship model the method is the same, but a single pointed rod is used in place of the T, the rod being held parallel to the wind direction. The method is not absolutely satisfactory in this case, as no allowance is made for the interference between supporting wires and the model, which is quite different from the interference between the supporting wires and the rod, but the percentage error from this cause is undoubtedly very small.

The wing models in use at Goettingen are all made of plaster, scraped to form while still soft. One or, more usually, two aluminum plates are used as the core. The finish is excellent, although no better than on the best of the models made for the Garden City laboratory. The standard size of wing model at Goettingen is 1 m. by 20 cm., an aspect ratio of 5.

The method of regulating the wind speed is of particular interest, as it is entirely automatic and seems to work with absolute perfection. The speed is fundamentally measured, in accordance with the usual practice by measuring the pressure difference between the large and the small sections of the tunnel. The pressure difference is measured by leading the pressure which differs from atmospheric in under a cup the rim of which dips in oil, and by weighing the lift on this cup with a balance, just as is done at the Leland Stanford tunnel.

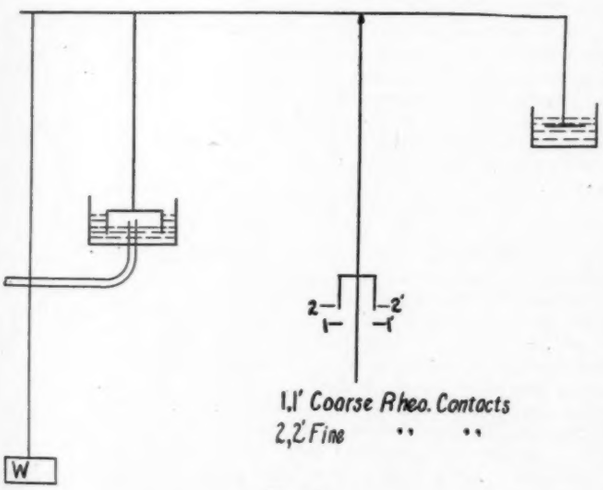


FIG. 1

In this case, since the pressure under the cup is greater than atmospheric, the weights have to be hung on the same side of the balance axis with the cup.

On the other arm of the balance is an oil dash-pot, while a long pointer runs downwards from the balance axis and moves between two contacts. The arrangement is shown roughly in Fig. 1. As the pointer makes contact on one side or the other a servo motor is started in one direction or the other, steadily moving a rheostat and increasing or decreasing the motor speed, in such a way as to bring the wind speed back to normal, until the contact is broken and the pointer once more floats freely.

In order to secure a greater range and a more sensitive maintenance of speed, the pointer is made with a subsidiary contact in the form of a light flat spring on each side of the main contact, and these subsidiary contacts actuate a fine rheostat. If the deviation from normal speed is really large, the unbalancing of the beam overcomes the resistance of the light contact spring and the beam moves far enough to bring the main pointer into contact with its stops and actuate the coarse rheostat. In order to prevent the fine rheostat being brought up against its stops, a contact is automatically made when the handle draws near to the limit of its travel and this moves the coarse rheostat one step. The whole adjustment is now automatic. There is a push-button starter, and, the motor once started, the operator has only to hang the proper weight on the balance (the weights are marked directly in meters per sec.) and go away and leave it.

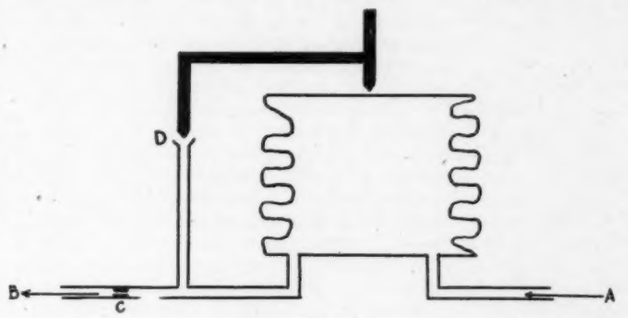


FIG. 2

Although it appears that not much stability work has been done at Goettingen, a balance for measuring all forces and moments simultaneously is now under construction and is nearly completed. For this purpose, the model is hung from the platform, the model being heavily enough ballasted to keep all the suspension wires taut. These suspension wires are rigidly attached to the platform. The platform is held in position by six wires, two running vertically, two parallel to the wind stream, and the remaining pair horizontally and perpendicular to the tunnel axis, and the simultaneous measurement of the tensions in all these wires permits of the calculation of the six forces and moments acting. This is much the same in principle as the roof balance which has long been used for certain special experiments at the N.P.L. and to the all-wire-support roof balance which is now being designed at the R.A.E. The most interesting and original feature of the Goettingen balance is the automatic adjustment of the six balances, all of which are arranged in a row before the operator.

The method is best explained by Fig. 2. The arm of the balance which is to carry the weights bears against the top plate of a very flexible sylphon into which air at a low presure is continually pumped through the pipe *A*. The pressure which can be reached inside the sylphon is limited by the outflow pipe *B*, which contains a constricton at *C* to permit the building up of a pressure. The balance arm has attached to it a horizontal rod and a needle-valve controlling the outflow from the main supply pipe by another passage without passing the constriction *C*. If the pressure inside the sylphon is so great that the total lifting force on the top plate is greater than the downward pressure of the balance arm the arm is lifted, opening the air-valve at *D* and permitting a drop of pressure and the descent of the arm and re-closing of the valve.

This apparatus, however, sustains only a small part of the maximum force acting on the balance, and weights must be hung on the balance arm in the usual way. These weights are normally carried by fingers on a rack which can be moved vertically by rotating a hand-wheel, and, as the rack is lowered, the weights are transferred to the scale-pan one at a time. The amount of weight resting on the scale-pan at any time is shown by a revolution counter attached to the hand-wheel which adjusts the rack. In taking a reading, then, it is only necessary to rotate the hand-wheel until the balance arm drops, to turn on the air at the sylphon, and then read the revolution counter and the air-pressure gauge. All six of these balances could be operated without difficulty by a single observer. On

this new balance, as on the one now in existence, the workmanship is good where it needs to be good, but no time or money has been wasted on finish where it does not affect the working of the instrument. The sensitivity of the balance now in use is a little better than 1 g., both on lift and drag.

No propeller testing has been done at Goettingen recently, but a propeller balance of unique type has been designed and partially constructed. The propeller under test will be driven through bevel gears and a vertical shaft from a motor outside the wind-stream, and the whole apparatus, motor, transmission, and propeller, will be carried on floats in a tank of water or oil. The thrust is to be measured by the combined pull in two wires running parallel to the wind direction, the torque by the pull which has to be applied to a vertical wire attached to one side of the floating platform in order to keep that platform horizontal. The cross-wind force and pitching and yawing moments can also be obtained with ease if desired by running other wires in suitable directions. In order that the measurements of torque may be sensitive, the inherent stability of flotation must be small, so that the angle of tilt due to the torque would be large were it not for the restraining wire. In order to accomplish this the metacentric height must be reduced or, since metacentric height is equal to I/V and V is fixed by the weight of the apparatus, the moment of inertia of the water-line section about a longitudinal axis must be made as small as possible without actually bringing the metacenter below the center of gravity. This is done in the Goettingen apparatus by making the floats proper of such a size that they will be completely submerged and the surface of the water will only be broken by the tubes which connect the floats to the platform. The propellers tested are to be one meter in diameter.

Aerodynamic Work at Aachen

The laboratory equipment, under Prof. Karman, however, is very limited. The only wind tunnel available is on the roof of the building and takes its air from the free atmosphere, with no protection from gusts. It is also very short, and the flow is so irregular that it would be impossible to work with wings or, indeed, to do any work at all with a balance. The tunnel is two meters in diameter and has a 100 hp. motor, realizing a speed of 33 m. per sec. There is no expansion in the exit cone, the Sirocco fan which produces the current being of the same diameter as the throat of the tunnel. The experimental chamber is enclosed as in the Eiffel type, and the irregularity of the flow in the stream is attested by a pronounced circulation of air all around the chamber. The honeycomb cells appear too large for best results, being about eight in. in diameter and two ft. long. The most interesting thing about the Aachen tunnel itself is its noise-making characteristic. Up to about 25 m. per sec., while not by any means silent, the amount of noise is not unusual for the corresponding size and speed. At that speed there is a sudden change, and above 25 m. per sec. there is an ear-splitting shriek totally unlike anything I ever heard from a wind tunnel before. The most peculiar thing about it however, is that if one thrusts an arm into the stream until the hand is near its middle the high-pitched noise instantly stops, recommencing as soon as the arm is withdrawn.

At the present time the Aachen tunnel is working chiefly on the heat dissipation from and the flow of air through radiators. In carrying out these experiments a section of the radiator is closed off from the remainder, so that no water can flow through it, and minute holes are made in the sides of these isolated passages. Connecting the holes thus made to a gauge, the static air pressure is found at several points between those where the air enters and where it leaves the radiator, and the resistance can be studied and computed from the pressure gradient thus found, in the manner commonly employed in examining the flow of fluids through pipes. Water is pumped through the radiator at variable speeds and variable inlet temperatures and the heat dissipation is computed in the usual way.

A small water-channel is being used for photographing the flow through diverging and converging passages of various sorts with a view to analyzing the flow in the exit and entrance cones of wind tunnels. Aluminum powder is used for making the flow visible. The most striking thing about the results so far obtained is the abrupt change in type of flow which appears about ten seconds after the motion has commenced, the flow initially "filling" a diverging cone and then breaking away from the walls, passing straight down the center as a stream of approximately constant cross-section with a region of dead-water on each side. Unfortunately, no moving pictures have as yet been taken to show the exact mechanism of the change. The alteration of the flow probably depends at least in part on the cessation of acceleration and the establishment of steady conditions.

The Junkers Laboratory at Dessau

This wind tunnel is hardly to be compared with Prandtl's, as the aim in its construction was entirely different. The Junker's laboratory is admittedly solely commercial in its aims, its only object being to furnish data for improving the Junker's airplanes. None of the work done there has been published, and there is no intention of publishing any. The experiments at Dessau have been chiefly concerned with the development of improved sections for cantilever wings, although a little stability testing of an elementary sort has been undertaken, and the constant attempt has been to speed up and systematize the making of routine tests with a moderate degree of accuracy, rather than to seek increased refinement in measurement.

The Junkers tunnel is octagonal in section, but the octagon is not a regular one, and the breadth of the stream being 1.2 m., the height only 0.9. A fan is used instead of a propeller for producing the air-current. The tunnel is of true Eiffel type as regards the experimental chamber, and a couple of inches of water is left standing on the floor at all times to minimize leakage and to suppress the dust. The drive is by an electric motor of 100 hp., and the maximum wind-speed is 39 m. per sec., giving an energy ratio of .497.

The steadiness of flow in the Dessau laboratory seems distinctly inferior to that of Goettingen, and there is no question that there is more disturbance of the air in the room and spreading of the stream. The honeycomb is similar to that used by Prof. Prandtl as far as the form and arrangement of the cells are concerned, but it is placed at the beginning of the throat instead of at an enlarged section. The cells are ½ in. in mean diameter and 2 in. long.

The balance in the Junkers laboratory is of interest chiefly because it is completely autographic. The measurments depend entirely on springs, no weights being used. The balance carriage slides longitudinally and is carried on two steel rods running parallel to the wind direction. The weight of the carriage is considerable, and the friction in sliding on fixed rods would be intolerably large, but this friction is practically eliminated by rotating the rods at high speed through a belt drive,—a very ingenious and successful method. The longitudinal motion of the carriage is proportional to the drag, and is transmitted through a linkage to a pencil which moves vertically over a record-sheet. The lift is measured by the tilt of a beam which carries the model and which is also restrained by springs, and is also transmitted through a linkage to a pencil making its record on the same sheet as the first one. The angle of attack is changed steadily and progressively by a motor which winds up a wire attached to the trailing edge of the model, and which, at the same time, rotates the drum carrying the record-sheet at a constant speed. The making of a complete test requires only about twenty minutes. No attempt is made to keep the speed constant automatically, the rheostats being set at a beginning of the run and then left alone. It is assumed that the changes in speed due to voltage changes are negligible.

The wind models tested are made of wood. A very large number of thick wings have been tested, and work is still continuing in the effort to improve the present Junkers wing. The best results obtained to date with thick wings at Dessau are: Max L/D, 170: Lc, 0.65, at 35 m. per sec. The maximum lift coefficient is not in any way remarkable, and the high maxi-L/D is largely accounted for by the way in which the model was supported. All tests are made with the aerofoil carried by a stream-line spindle about 3/16 in. wide passing into the model at the center of the span and near the leading edge, and it is well known that such a support, when its resistance is corrected for in the usual approximate fashion, leads to values of the drag which are far below the correct figures.

The Zeppelin Wind Tunnel at Friedrichshafen

The only remaining wind tunnel of any importance is that which is under construction, but not yet completed, for the Zeppelin Airship Co. To be sure, there is a tunnel at Adlershof, but this is old and little used.

The Zeppelin tunnel has been designed by, and is being built under the supervision of Dr. Max Munk, and is similar in many respects to the Goettingen installation. The Zeppelin tunnel, however, is considerably larger than either of those at Goettingen, and will be the largest tunnel in the world from the time of its opening until the new 7 x 14 ft. channel at the N.P.L. goes into action. The diameter of the wind-stream at Friedrichshafen is 3 m. The drive will be by two Maybach engines coupled in tandem, delivering a total of 500 hp., and a speed of 30 m. per sec. is anticipated.

The most original feature of the tunnel design lies in the provision of air-tight gangways, of much larger section than the tunnel itself or even than the large end of the exit cone, for the return of the air. The principle is the same as a Goettingen, but the mechanical execution is somewhat different, largely because of the great size of the laboratory. There are two return passages, one on each side of the tunnel, instead of a single one, and these passages take the form of gangways each about three meters wide and six meters high, with air-tight windows and air-locks and without any guide vanes at the corners. The passages are shaped at the ends so that there will be as gradual a change of section and of direction as possible, the whole, including the entrance cone, being made in concrete. The exit cone, however, is of wood. Since the gangways are air-tight, the throat section can be open to the atmosphere, just as at Goettingen, and admission to the test room is perfectly free at all times, no air-lock or other control being necessary. In order to permit access to the test chamber there is a subway under each of the gangways.

The slope of the exit cone is small, the vertex angle being 7½ deg, and the length is not sufficient to give as large an area ratio as is the usual custom. The length of the cone is to be 15 m. and the diameter of the propeller 5 m., the propeller being driven with the same gear reduction as is employed in the Maybach engines on Zeppelin airships.

No honeycomb has been fitted as yet, and Dr. Munk hopes to avoid the use of any straightening device, but his hopes apparently have no sound basis.

The measuring instruments will be of the same general type as those at Goettingen, but naturally much stronger. The whole weighing apparatus is to be installed on an overhead platform where the observers will work, the support being by steel rails carried by concrete piers. The most striking feature about the balance is its construction, which follows Zeppelin airship lines faithfully, the cross-beams used for weighing the lift being built-up duralumin lattice girders. The total weight of the moving parts will certainly be less than in any other balance ever built for so large a *VL*. Of the two bridges, the forward one will be fixed rigidly to the rails, but the other will be mounted on wheels and will be allowed to move longitudinally as the angle of attack is changed so that the horizontal distance between the two bridges will always remain equal to the horizontal distance between the lower ends of the two sets of wires. The adjustment of the angle of attack is by raising one of the bridges, the supports for which slide on vertical rods. The bridge is raised with a cable which is wound up on a drum by turning a graduated handwheel.

The speed is to be controlled automatically by the same method as that employed at Goettingen, the servo motor operating the engine throttles instead of a rheostat.

The Study of a Steam Turbine for Airplanes

By Luigi Acampora

Navigation at very high elevations, where less air resistance is encountered, and where the air is free from atmospheric disturbances, is one of the most interesting problems of modern aviation, be it from a military viewpoint for the obvious advantages which it would present in case of war, or be it from a purely commercial angle on account of the rapidity with which long distance communication could be realized. The possibility of obtaining a velocity N times greater, with the same power, by flying at an elevation where the density of the air be N^2 times smaller is theoretically proven.

But aside from this, it is an irrefutable disadvantage of the internal combustion engine, even at limited elevations, that the average pressure on the surface of the piston diminishes in proportion to the air density. Of this the motive torque is a function, and consequently a lowering in power is produced equal to about 10 per cent for every 1000 meters of elevation.

Considering, with sufficient approximation, that the power decreases proportionally to the barometric pressure H, at an elevation Q, the power T is given by $T = SB$, where S is the power at sea level, and $B = \frac{H}{760}$

The fractional decrease in power will be

$$1 - B = \frac{S - T}{S}$$

From this formula we have that the per cent decrease at various levels is:

46.5 per cent at 5000 meters
64.0 per cent at 8000 meters
72.3 per cent at 10000 meters

In order to remedy this disadvantage at increasing altitudes, aeronautical engineers have studied various schemes which in general are based on the use of the turbo-compressor which over feeds the carburetor. These are, however, complicated, and have been shown to be rather an artificial remedy.

The natural remedy would be to carry aboard liquid oxygen and to use it as the rarefaction of the air increases; but this scheme is rendered less attractive by prohibitive weight, because it is computed that for every kilogram of gasoline there are required four kilograms of oxygen.

A radical remedy would be to conceive a power plant whose power would be independent of the density of the air, and in this line of thought various Italian engineers look forward to the steam turbine. The latter gives hopes of several advantages besides those of the constant power and the elimination of the dangers inherent to the use of gasoline.

Without going into the use of steam power for airships, experimented with by Forlanini among the first in Italy, the idea of a steam engine for airplanes is not at all a new one. From the first experiments made by Hiram Maxim (1887—1891) to the noteworthy achievement of Ader, steam has been used as a prime mover in airplanes. It is interesting to note that the steam engine by means of which Ader was able to lift this airplane only weighed 100 kg. and developed 30 hp., that is, weighed 3.3 kg. per hp.

The gasoline engine employed ten years later by the Wright Brothers gave 25 hp. and weighed 90 kg., or 3.6 kg. per hp.; and further in 1910 the first type A (Aviation type) Fiat, a product of many experiments which had shown the dangers of excessive lightening, gave 40 hp. and weighed 100 kg.

Why then was steam abandoned?

An impartial scientist, Prof. Mayer, wrote in 1912 that development of the internal combustion engine was "a process of rapid fermentation," and it is to be agreed that if all the technical men and scientists of the world had dedicated themselves to improve the steam engine, as has been done for the internal combustion engine, today the latter would not be alone in traveling through the air, unable to reach very high elevations, and notoriously lightened at the cost of decreasing its durability or by exceptional materials (a magnesum alloy of aluminum has been employed with a specific gravity of 1.8).

Today the best aviation engines have an average weight of 1200 grams per hp., excluding the fuel, and a turbine is figured to give a much larger weight; this is true, but the problem must not be stated with this simplicity. Let us remember that our purpose is to be able to fly at very high elevations, say at least 10,000 meters, and there the total weight of the engine is to be divided not by the number of horsepower obtained at sea level, but by the residual fraction which is a result of the smaller value of the motive torque.

Let us analyze, for example, the possible solution of the problem for a comparison between two propelling groups, at 8000 meters. A comparison may be made with the Dorand formula

$$M : \frac{Pu}{T} = M^1 : \frac{Pu}{T^1} \quad \text{.....(A)}$$

where M is the weight per hp. of the internal combustion engine increased by the weight of gasoline and oil needed for a fixed number of hours, for example three hours.

M^1 is the same weight as computed for the steam turbine.

Pu is the useful weight, which must be equal in both cases.

T is the gas engine power at 8000 meters.

T^1 is the steam turbine power (independent of altitude).

Let us apply the formula to one of the most modern gas engines which gives considerable power at high elevations, that is the type Fiat A-14 which weighs 730 kilograms and consumes 275 grams of gasoline and oil per hp.

If normal power, guaranteed at sea level, is 600 hp., at 8000 meters it is only 216 hp. Therefore to compute M^1 it is only necessary to remember that the weight of the engine group (excluding propeller and hub) is given by:

Motor	730	kg.
Radiator and piping empty	77	kg.
Tanks and piping empty	85	kg.
Accessories	6.8	kg.
Water in radiators	43.0	kg.
Gasoline for 3 hours flight at 8000 meters	158.76	kg.
Oil for 3 hours flight at 8000 meters	19.44	kg.
Total	1120.0	kg.

From formula (A) we deduce that, for equal power efficiency of the two groups $M = M^1$, therefore we can conclude that in order to use a steam turbine to fly at 8000 meters, in the same manner as with a Fiat A-14 engine, we can estimate on a steam turbine weight of 1120 kg.

For greater altitudes than 8000 meters, and for those altitudes which the internal combustion engine is not even able to reach, the steam turbine offers still greater advantages.

In the case of flying at 8000 meters, a turbine of 216 hp. weighing 5.18 kg. per horsepower is equivalent to a 600 hp. motor weighing 1.86 kg, per hp. under the same flying conditions: Subtracting from the 1120 kg. the weight of the fuel consumption for three hours of flight, based on 216 hp., the net weight of the motive apparatus is obtained.

What has been said above, only has value for a particular case, but in that manner we have reached a weight determination, useful as an example, because it is essential to note that we set the condition of equality in useful loads Pu.

If we consider the useful load equation

$$Pt = a\ Pt + Pm + Pu$$

in which

Pt is the total weight, a is a constant usually equal to 0.30; Pm the weight of the motopropulsive apparatus (in our case it is equal to 1120 kg. + 30 kg., weight of the propeller = 1150) and Pu the useful load, we obtain that

$$Pt = 0.30\ Pt + 1150 + Pu,$$

and by varying Pu we can obtain Pt and therefore the load per hp., the ceiling of the machine, and other characteristics for the computation of the machine.

Having thoroughly demonstrated that for flight at greater altitudes than sea level, the internal combustion engine, besides the disadvantage of the lowered power, gives a higher weight per hp., than is ordinarily considered, we will touch on the requisites which should be kept in mind in planning another engine.

(1) *Power*: It is advisable to keep the horsepower between 200 and 250 hp. The propeller must make about 1200 r.p.m. perferably less.

(2) *Lightness*: Considering the consumption, it is necessary to lighten all the parts of the motive group, as it has been done gradually for the internal combustion engine, trying to avoid however the use of exceptional materials.

(3) *Center of Gravity*: As low as possible, with the masses as concentrated as possible.

(4) *Inclination*: The engine must perform even if inclined up to 10 deg. forward or backward.

(5) *Volume*: It must give as low a resistance to penetration as it is possible.

(6) *Durability*: For the internal combustion engine it is necessary to pass a 50 hour running test before the type is accepted.

(7) *Other Qualities*: Facility for assembling and dismounting, facility in inspecting the various parts, maximum guaranty against accidents during flights, possibility of decreasing the number of revolutions of the propeller.

German Airship Situation

Germany, through the Zeppelin Airship Company, has requested permission of the Inter-Allied Commission on Air Control in Germany, to construct two giant airships for use in international trade between the United States and Germany. According to advices received here in official circles, the request was temporarily refused.

Negotiations with the commission included an effort to obtain sanction for Germany to retain a certain proportion of her airplane, seaplane and airship stations for use in international and interstate traffic. Lists of all air stations were prepared by the German air officials. There are said to be approximately 600 public and private stations, of which the Germans hoped to retain some 20 per cent.

PLACQUE PRESENTED TO BELGIAN AERO CLUB

The Lafayette Flying Corps - An Epic of the Air

A Review by Philip J. Roosevelt

It is in fact an epic of Homeric proportions that Captain Hall and Lieutenant Nordhoff have compiled to preserve in enduring form the history of the Lafayette Flying Corps. In two beautifully printed volumes* filled with interesting and well reproduced illustrations is set forth a brief resume of the history of Squadron N. 124, later Spad 124 of the French Army, and finally the 103d Aero Squadron U. S. Army as well as a short account of the other American pilots who joined the French service before the entry of the United States into the war and served in 66 pursuit and 27 observation or bombardment squadrons of the French army flying over every kilometer of the long line of battle that for four years stretched from Switzerland to the sea. A brief biography of every member of the corps is included in volume one.

It is to the second volume that everyone interested in aeronautics must turn and return again and again for a classic presentation of life at the front in the Air Service. This volume contains a compilation of pilots' letters written during the fighting, for whose careful selection and arrangement the editors deserve unstinted praise.

No story in all history contains more gallantry, more unselfish sacrifice, more noble adventure and few contain more of notable achievement than the story of 180 members of the Lafayette Flying Corps who served at the front in Escadrille Spad 124 or in other French squadrons. Sixty-five met death, sixteen were taken prisoners. Altogether they gained 199 aerial victories. Eventually they formed the backbone of the American Air Service on the front.

These men, for though the fashion may have been to call them "boys" that term is unworthy, left their country to deny themselves everything easy and comfortable and to stand before all the world as exponents of a cause they knew to be the cause of right. It is characteristic of the Corps that its members sought no personal publicity then and that now, when a record of their deeds is compiled, the letters which go to make it up are published anonymously.

In April, 1916, Norman Prince, William Thaw, Victor Chapman, Kniffin Rockwell, James McConnell, Elliott Cowdin and Bert Hall received their orders from the French Army to commence operations at Luxeuil. Here Rockwell and Prince were killed. Six months after its original muster it moved to the Somme. It was while on the Somme that the official representations of the highest American authorities caused a change in the squadron's name. Hitherto known as the Escadrille Americaine the authorities at Washington disowned its seventeen official victories when von Bernstorff called attention to them and the squadron's name was changed to the Escadrille Lafayette.

The move to the Somme and the hard fighting there was succeeded by other moves; for wherever the hardest fighting was, there was concentrated the nomadic force of French pursuit aviation in which the Lafayette Escadrille was comprised. Flanders, the Aisne and the Champagne all furnished airdromes for this organization whose fighting personnel, except for a captain and a French lieutenant, was American. These Americans were the torchbearers who lighted the way and in whose footsteps the American Expeditionary Force merely followed.

At the same time the Escadrille Lafayette was fighting its way to fame other Americans were trained at Pau and Avord and passed from G. D. E., the pilot pool at Plessis Belleville, into other French squadrons at the front.

By no means the least of the criticism which the American Army in France must leave forever unanswered is the criticism arising from its neglect of this war-trained personnel. Not until October 1, 1917, did our authorities abroad begin to make motions which would render this personnel available to our army and what feeble motions were made is well shown by the fact that many of the Lafayette pilots were released by the French weeks and months before receiving their American orders to active duty. These men, nevertheless, continued to fight. Though not in any army they won victories and some died or were taken prisoner as *civilians!* It was not until February, 1918, that they were made a part of the American Army.

As officers of our army, members of the Lafayette Squadron and the Lafayette Flying Corps formed the backbone of our pursuit aviation. The service which Lufbery, James Norman Hall and Peterson rendered both by handing down a tradition and by their personal example to the 94th and 95th American squadrons and to the entire 1st Pursuit Group has been acknowledged by Rickenbacker in his book. That service can never be overestimated. Similar service in other squadrons and groups was rendered by men like Charles Biddle, Lester Brady, Meredith Dowd, Charles G. Grey, Dudley Hill, G. de Freest Larner, David Putnam, Robert Soubiran, George Turnure and William Thaw all of them group squadron flight commanders. The members of the Lafayette Flying Corps who were engaged in observation or bombardment work were much fewer in number than its pursuit pilots but as a leader of bombardment expeditions Andre Gunderlach who came from the Lafayette Corps stood alone in the American Army until he met death and no officer in Army Corps observation work commanded his organization with greater success or distinction than Kenneth Proctor Littauer (Latour), another of the Lafayette fliers.

But what of life in the Air Service at the front? For thrill piled on thrill this compilation of letters, all interspersed with the characteristic snatches of "argot" and matter of fact good humor, surpass any similar chronicle with which the reviewer is familiar.

"To fall from 3500 meters in a machine from which half of the tail had been cut away! To escape with nothing but a few scratches." That makes one story. The infantry attack at dawn in which the pursuit Air Service take off in pitch darkness flies over the red gleam of the line of battle and watches the cloud effects of the sunrise through its straining gaze for enemy aircraft makes another.

More than one of the Lafayette fliers was forced to land in No Man's Land, and reached our lines safely to resume his daily routine of patrols, high, low and intermediate.

There are two accurate and absorbing accounts of the work of the 3d Pursuit Group, U. S. Army, of which the Lafayette squadron formed a part, in the reduction of the St. Mihiel salient. From daylight till dark on September 12 and September 13, 1918, this squadron and the remainder of the group machine gunned and bombed with little 16 pound bombs the road between Pannes and Beney, filled with troops, camions and artillery of the retreating enemy. Incidentally seven Hun aircraft were brought down by the Group in that fighting.

Every user of aircraft and every war historian should read the long letter, Volume II, pp. 212-217, estimating the comparative merits of Allied and German pursuit planes from the point of view of performance. Very little publicity has been given to the belief shared with this pilot by the large majority of his associates: "The Germans ended the war with better machines than ours."

Fights in the early days of Boelke, in the days of von Richtofen and in the closing days of the "Tangos" "Checkerboards" and "Red Noses," "dog-fights" over the Huns in the Chateau Thierry Salient and over the Argonne all are chronicled with the thrill of actual participation and yet with that casual good humor and thoughtlessness of self which characterized the Lafayette Flying Corps from first to last.

No review of these volumes would be complete that did not mention the four reproductions of paintings by Lieutenant Vimnera of the French army, one of which forms the frontispiece of each volume. These paintings are worthy to rank with Farre's best; in fact Vimnera has caught the atmosphere of a "dog fight" and put it on canvas for all time.

All in all, these volumes deserve the supreme tribute; they are worthy of the Corps, and of the individuals who composed the Corps, whose deeds they chronicle.

* "The Lafayette Flying Corps," two volumes, by James Norman Hall and Charles Bernard Nordhoff; published by Houghton, Mifflin Co., Boston, Mass.; price $15.

Report of Canadian Air Board

Progress Report No. 2, covering activities of the Canadian Air Board for period, Aug. 1 to 31, is one of unusual interest. Of the matters considered, especially noteworthy are the following: Reports of recent flight operations; of the Associate Air Research Committee; on air navigation instructions for commercial fliers, and the application of air regulations to civilians; on forest survey; and on aviation insurance.

The research committee, while considering various proposals for conducting specific researches, is concentrating for the present on the following:

(1) Wind tunnel investigations on the aerodynamic effect in plan form of various types of wing tips.

(2) Investigations with regard to the improvement in design of barographs with special reference to the question of diaphragm.

(3) Investigations on the operations of aero engines at extreme low temperature with special reference to carburation, oiling and cooling.

Finding the facilities sadly lacking for giving adequate instructions to such applicants as may present themselves to obtain certificates as commercial air navigators, plans are being considered to have the universities make special provision for night classes in aviation navigaton, and, also to provide a suitable curriculum at the training center, Camp Borden, which would take into consideration the training of air personnel.

In this connection, in order to enable the superintendent of the certificates branch to deal more effectively with cases of non-compliance or breach of air regulations, this officer has been empowered by the Board to take action when necessary to suspend license, temporarily, pending confirmation at the next meeting of the Board.

Of the applications received for certificates, the following figures are interesting: from private air pilots, 57; from commercial air pilots, 88; air engineers, 54; air navigators, 2; air harbor licenses, 42; and registration of aircraft, 92.

In the matter of forest survey, the Board has been requested to cooperate with the Conservation Commission of Ontario. It was also suggested that much benefit would result from such cooperation with the Department of Agriculture, whose entomologists are in need of quick transportation to inaccessible regions in connection with outbreaks of spruce budworms and like pests.

Of paramount interest is the action of the Board in the important matter of aviation insurance, which is further reported in a special bulletin. In an effort to interest the various insurance companies operating in Canada to accept aviation insurance, both as regards personnel and machines, some 100 firms were circularized with a letter over the signature of the secretary of the Board, pointing out the importance of this class of insurance in the development of commercial aviation. Appended to the letter was an extract from the last report of the Controller General of civil aviation in Great Britain, for a period covering six months, showing the relatively small number of accidents which have occurred in proportion to the number of hours flown by civil aircraft.

The flying operations branch reports a number of interesting activities. Plans were presented for a trans-Canadian flight to take place sometime in October, the approximate cost of which would be $7,000, the objects summarized are as follows: To demonstrate the feasibility of such a flight from a commercial point of view; to prove the possibility of a fast trip from coast to coast without undue strain on pilots or machines; to serve as recruiting propaganda for the Air Force and to stimulate interest in aviation generally.

An attractive feature of this flight will be its amphibious character, it being planned to take the start at Halifax with a Fairy trans-Atlantic type 3 C seaplane, to make the water route across New Brunswick to the River St. Lawrence in the vicinity of Fraserville. From that point, DH-9 airplanes will pick up the journey in relays to Quebec, Montreal, Ottawa, Nipissing, Sault Ste. Marie and Kenora to Winnepeg.

Extracts from the log of the flight from Halifax to Ottawa in flying-boat G-C Y A G, carried out Aug 26-28 by Capt. H. Allen Wilson, pilot, and S. Macauly, engineer, follow:

Thursday, Aug. 26—At 1:38 p. m., we left Halifax and after a flight of 3 hrs. and 42 min., landed at Fredericton.

Friday, Aug. 27—Owing to heavy fog which covered land and water, we were unable to make an early start. The fog lifted shortly after 9 a. m., and we left at 9:45. After 4 hours and 5 min. flying we landed at Riviere Du Loup, having encountered a very heavy head wind for the last 30 miles of the lap, between Lake Temisconnata and Riviere Du Loup. After great difficulties in gaining the pier, owing to condition of wind and tide, we commenced refilling the machine, which was a very slow process since, by reason of lack of facilities, all the gasoline had to be lowered in a 5 gallon can over the edge of the pier. No airplane gasoline being available, necessitated refilling with 35 gallons of Queen quality and 40 gallons of Premier quality.

We left Riviere Du Loup at 5:10 p. m. and, running against a very strong head wind, after 2 hours and 20 minutes to cover distance of 110 miles, landed at Quebec at 7:30 p. m. After ascending into the air at Riviere Du Loup, the tank containing Permier gasoline was used. The engine gave perfect satisfaction with this grade of gasoline, but it would appear that more gasoline of this quality than of Queen quality is consumed in the same length of time. For instance: one tank containing 40 U. S. gallons of Premier lasted 1 hr. and 15 min., in comparison to 40 gallons of airplane gasoline which lasts 1 hr. 30 min.

Saturday, Aug. 28—We left Quebec at 8:40 a. m., and after 2 hrs. 10 min. flying, with excellent flying conditions, landed at the Canadian Vickers in Montreal, east, at 10:50 a. m.

Leaving Montreal at 5:30 p. m. and after 1 hr. and 40 min. flying, landed at Ottawa air station at 7:15 p. m.

Total flying time for the journey was 14 hrs. 7 min., covering a distance of approximately 792 miles.

K-6 Tried in JN-4

Many of the most prominent fliers in the country have speculated as to what would be the result of combining a Curtiss JN-4 with a Curtiss K-6 motor. The plane referred to has usually been equipped with an OX-5 90 hp. motor, which combination was used for instruction to more than 90 per cent of U. S. and Canadian army fliers.

The K-6 motor, which is rated 150 hp., is the usual equipment in the Curtiss Oriole. In the Oriole it attains a maximum speed of 100 miles per hour.

Although the Jennie K-6 combination has been pronounced feasible by practically all who had discussed it, it remained for Earl Cooper to actually try it out. So far as is known, the plane thus equipped, that made its trial trip from the Marina recently, was the first one on record.

The pilot, Dan Davison, pronounced the trial trip an unqualified success, and was enthusiastic in his praise of the ship's responsiveness.

"Pinta" Rescues Drowning Man

According to the *New York Evening Post,* a drowning man was rescued at Georgetown, S. C. late in the afternoon of October 28, by the *Pinta,* one of the big air cruisers of the Aeromarine West Indies service now on their way to establish a mail system between Havana, Cuba, and the United States.

The man had been swimming in Winyah Bay, near there. He had ventured out too far and was being rapidly carried out by the tide. A life saving boat from the shore tried to go to his aid, but on account of the swiftness of the current could make little headway and would have been unable to reach him in time to save his life.

The *Pinta* happened to be lying in the harbor to avoid a storm and, seeing the man's distress, sent one of its crew out with a line tied to him and a life preserver, then taxi-ing over the water, it came near enough to the drowning man to reach out and haul him aboard.

Presentation of the Gordon Bennett Trophy

Over twenty members and guests of the Aero Club of America attended the dinner and presentation of the Gordon Bennett Trophy which took place at the club house, 11 East 38 street, New York, on Monday evening, November 1. The occasion was the formal presentation of the Gordon Bennett balloon trophy to this year's winner, Lieut. Ernest Demuyter the pilot of the Belgian balloon Belgica.

Jefferson deMont Thompson, the president of the Club and Allen R. Hawley, the former president were the hosts. The majority of the contestants were present and a cordial spirit was shown between the victors and the vanquished. Both Lieut. Demuyter and Lieut. Labrisse, his aide were present in person. Dr. Kinsbury represented the American entries. Capt. Hirschauer and M. Nathan, his aide, were present.

The Italians were represented by four of their party; Maj. Valle who won the third place, Maj. Medori, Maj. Leone and Lieut. Pirazzolli. Among the non-participants present was Pierre Maili, the Belgian Consul-General in New York. Col. B. F. Castle, the chairman of the contest committee of the Aero Club, attended the dinner. The group was brightened by the uniforms of the foreign officers. Conspicuous among them was Col. Cedric Fauntleroy, the commander of the Kosciusko squadron of the Polish army.

THE GORDON BENNETT BALLOON TROPHY

The dinner was held in the main dining room of the club which was specially decorated for the occasion. The Belgian flag was conspicuously displayed. Lieut. Demuyter brought his own flag of which he naturally feels very proud.

The dinner was served by the club and came up to specifications in every way that could be desired. The guests were seated at a T shaped table with Lieut. Demuyter at the head, the officials of the club being placed by his side. Speeches were made by Mr. Mali, Maj. Valle and Dr. Kingsbury declaring that the trophy was honestly earned.

The formal presentation of the trophy was made by Mr. Hawley, who pointed out the number of contests that it had been the prize for and the international nature of the event. He said that America was only too glad to deliver such a valued trophy to a club whose representatives had made such a fine showing among such a large field of skillful competitors.

Lieut. Demuyter thanked Mr. Hawley for his praise and told some of the incidents of his voyage. At one time he reached an altitude of 22,000 feet above sea level and both he and his aide were very uncomfortable owing to the fact that they had used the oxygen apparatus and some of their food as ballast. Snow storms were several times encountered. The greatest adventure of all was the landing and the skill and courage employed to save the balloon and reach land unaided.

The landing was made in the waters of Lake Champlain about two and a half miles from the Vermont shore. The partially deflated bag was above the water and the balloonists used it as a sail to enable them to navigate to the shore. This is an example of what a balloonist in an international race must be prepared to face at any time and the Belgian officers deserve much praise for their courage and skill.

Col. Fauntleroy then spoke on the difficulties of the American fliers in Poland and said that they had eighteen machines of eleven different types. He pointed out that not one of the machines was of American manufacture but said that he expects to purchase some of the latest models for use in defense against any future attacks on the Polish nation.

This dinner is the last step in the race. Belgium now has the trophy and it is distinctly up to the United States to win it back next year. In the past, Americans have won the trophy four times.

Japanese Air Mail

Inauguration of an air mail service by the Japanese Department of Communications is expected to take place before the end of the year. Investigations as to the existing state of aviation in Japan, the number of aviators, their education, the capacity of Japan to manfacture airplanes or other planes are now being made. Also the airdromes, the air routes, etc., are being inquired into.

The opening of the air mail service is expected to occur soon after Mr. Oyamada, an official of the Department of Communications who was sent abroad to investigate, returns to Tokio.

It is understood the first route to be tried will be between Tokio and Osaka, which was experimented upon by the Imperial Aviation Society last year, in the contest conducted then. The routes to Kyushu and Shikoku will be investigated when the second contest for long flights will be given next month. It is understood that the opening of all other routes will also be entrusted to the Imperial Aviation Society.

German Plans Alarm British

Sir Trevor Dawson, Vice Chairman of the Vickers Company, which is largely interested in constructing airplanes and airships, thrilled the final session of the Air Conference held at the Guildhall. Sir Trevor told the assembly that the Zeppelin company is negotiating with American interests for the organization of an air service operated from a base in Spain to the United States and South America. The Zeppelin company is now engaged on plans for airships of 3,500,000 cubic feet, capable of a speed of 100 miles an hour and of carrying thirty tons of passengers, freight and mails from San Francisco to Berlin.

So, Sir Trevor warned at the outbreak of the "next war" Germany would have air liners actually in operation which would at once deal death and destruction to England.

The discussion at the session turned chiefly on Great Britain's preparedness in the air for another war. A resolution unanimously adopted, called upon the Government, before granting any reform to Egypt, to take measures to secure a permanent air base at Cairo. The militarist tone of the whole proceedings was most significant.

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400 Miles in 178 Minutes

Flying at the rate of 148.38 miles an hour, Pilot Yeager of United States postal airplane No. 177, made the 400 miles from Salt Lake to Cheyenne in 178 minutes actual flying time, said to be a record for the trip.

Recruiting Skilled Mechanics

By Major General Charles T. Menoher

Chief of Air Service

With the Reorganization Act of June 4, 1920, the Air Service became definitely a part of the line of the Army. As such it was authorized a total of 16,000 enlisted men. This increase in authorized strength creates a number of vacancies in the Air Service. Once before a general announcement was made that enlistments would be received for the Air Service and thousands of men, quickly availing themselves of the splendid opportunities this branch of the service affords, enlisted. The Air Service was soon closed to enlistments. Now the opportunity is again offered men who already possess a knowledge of practical mechanics or who have a desire to acquire a knowledge of aeronautics. It is anticipated that the quota will again be quickly reached.

The two main branches of the Air Service are the Heavier-than-Air, (Airplane) and the Lighter-than-Air, (Balloon and Airship). The personnel and many of the functions of each are separate and distinct. Enlisted men of one branch are not transferable to the other without their consent. Applicants for enlistment may select either branch of the Air Service and are enlisted accordingly.

The Heavier-than-Air Branch now consists of 28 squadrons, 2 air park companies, 9 photo sections and numerous detachments of cadets and mechanics.

Squadrons, air parks, airship companies and balloon companies are comparable in size to an infantry company or a troop of cavalry. Detachments of men at special service schools for cadets and mechanics are varied in size, the Mechanics Training School at Kelly Field having an authorized strength in excess of 1,000 men.

The Air Service designs, constructs, tests, operates and maintains all types of aeronautical equipment. It cooperates with every arm of the service. It makes meteorological flights for the Signal Corps, makes aerial photographic maps for the Corps of Engineers, reconnoiters for the Infantry and Cavalry and tests aerial machine guns, aerial cannon, bombs and bombing equipment for the Ordnance Corps. It also conducts an aerial patrol to discover, locate and report forest fires. The list of the functions of the Air Service might be continued almost indefinitely, for it must see all, and interpret what it sees.

The Air Service being a corps of specialists, its efficiency must necessarily depend to a considerable extent on the skill and accuracy of its enlisted men. More than that, human life often depends upon this skill and accuracy. It is not to be wondered at then, if such painstaking efforts are put forth to guarantee the best of training for Air Service enlisted men. Every recruit enlisted for three years, who is not already a specialist, so classified by dependable records or by an Air Service trade test board, is sent to a school for specialists. The recruit may select any of the schools mentioned below, without regard to distance from place of enlistment, provided he has the potential qualifications to absorb the course.

Schools for Specialists

Mechanics (Airplane and Engine)—Kelly Field, San Antonio, Texas.

Photographers (Aerial)—Langley Field, Hampton, Va.

Communications (Radio)—Post Field, Fort Sill, Okla.

Stockkeepers—Wilbur Wright Air Service Depot, Fairfield, Ohio.

Mechanics (Lighter-than-Air)—Brooks Field, San Antonio, Tex.

Recruits accepted for one year are sent to the Air Service station nearest the place of their acceptance and are given, if they elect, a course of training in local vocational training schools. These schools are located at each Air Service Station and are in addition to those mentioned above. Air Service schools are organized to include all of its enlisted men and to cover every subject connected with its many activities. Special training is given to prepare men as:

Airplane mechanics; armorers, auto mechanics, blacksmiths, cabinet makers, carpenters, chauffeurs, coppersmiths, electricians, fabric workers, instrument repairmen, machinists, magneto repairmen, metal workers, motor mechanics, motorcyclists, propeller repairmen; plate developers, printers, balloon commanders, commanders, balloon riggers, gas men, winch men, radio operators, radio mechanics, telephone operators, telephone constructors and linemen, vulcanizers, welders, aerial photographers, draftsmen, master photographers.

Mechanics in the Air Service receive good pay and are never laid off. For specialists it is possible to receive the highest pay offered by the Army. Fifty per cent of base pay over and above all other pay may be paid for flying status. Most mechanics working on airplanes are on flying status, and receive this increase in pay.

Best Aeronautical Instruction

Aeronautical equipment is expensive, and it is doubtful if thorough training can be offered by civilian schools at any but prohibitive tuition rates.

The Air Service operates a large fleet of motor trucks, motorcycles, and passenger cars of every size and make which are driven and maintained by Air Service enlisted men. There is an opportunity in every phase of the automobile game for ambitious men.

Radio operators, mechanics and experts are always in demand. The training given by the Air Service Communication School is complete and thorough. Airplanes are now directed from the ground by means of wireless telephony and telegraphy and this requires skilled operators.

Aerial photography can be learned only in the Air Service. That aerial photography has tremendous possibilities as a commercial vocation is clearly demonstrated by the daily press, the magazines and the rotogravure sections of the Sunday papers.

There are exceptional opportunities in the Air Service for carpenters and particularly for cabinet makers. Practically every Air Service station repairs its own airplanes and this requires the services of expert wood workers.

The Opportunity to Fly

Par. 2, Special Regulations No. 111, War Department, 1920, states that any enlisted man of the Air Service between the ages of 20 and 27 years, inclusive who has the equivalent of a high school education may submit an application for flying training.

While no promise is made to give every enlisted man of the Air Serivce flying training, the opportunity is there for those who have the necessary qualifications. Enlisted men who qualify for appointment as flying cadets have in the past, are now, and will continue to receive flying training. Enlisted men successfully completing training as flying cadets may be returned to their organization for duty or may be commissioned as officers of the Reserve Corps. In any event they have received thorough training in the most fascinating work of the age, a vocation with exceeptional possibilities for capitalization.

Warning to Aviators

The U. S. Weather Bureau conducts upper air investigations by means of kites at the following stations:

NAME	LATITUDE		LONGITUDE	
Broken Arrow, Okla.....	36 deg.	02 min.	95 deg.	49 min.
Drexel, (near Elkhorn) Nebr..	41 deg.	20 min.	96 deg.	16 min.
Due West, S. C.....	34 deg.	20 min.	82 deg.	45 min.
Ellendale, N. Dakota.....	45 deg.	59 min.	98 deg.	34 min.
Groesbeck, Texas	31 deg.	20 min.	96 deg.	28 min.
Royal Center, Ind.....	40 deg.	53 min.	86 deg.	29 min.

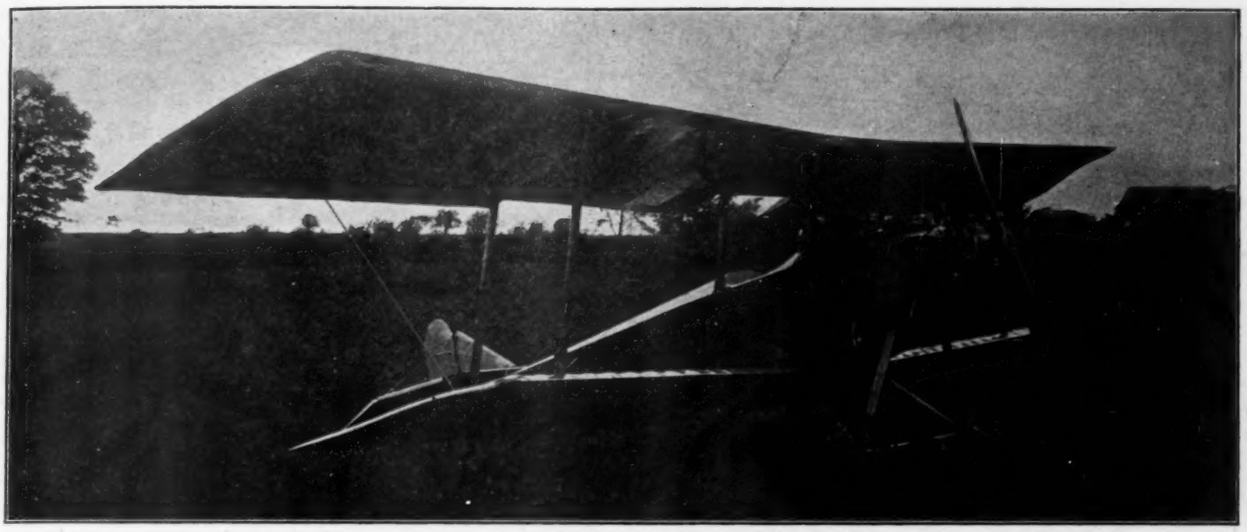
Aviators are warned not to approach within 10 miles of these stations, as serious, possibly fatal, accidents would result from the fouling of airplanes with the kites or with the wire by means of which the kites are flown.

C. F. MARVIN, Chief of Bureau.

The Skylark

The two-passenger, side-by-side seater Linderman biplane was given its first test flight on October 14, from Gernard's Farm eight miles from Bethlehem, Pa.

The machine is a design of Garrett B. Linderman, a Lehigh graduate and a resident of Bethlehem. Mr. Linderman during the war was an ensign, instructing flying in H-16 Navy flying boats at Pensacola, Fla. Being accustomed to large machines operated by wheel control and powered with two Liberty engines, he decided to take advantage of a pilot who has tested small land machines operated by a stick control and powered with motors of much less horsepower, the new machine being equipped with 3 cylinder 60 hp. Lawrance air cooled engine.



G. B. Linderman's Skylark

The pilot chosen for this work was Bruce Eytinge, of New York City, a former Lieutenant instructor in the Royal Air Force. Pilot Eytinge has had more time and experience on small light machines, with small horsepower, than most pilots and was well qualified for the test.

The Linderman biplane is of standard design and construction throughout. The wing spread of the top plane is 28 ft., including a three foot overhang. The ailerons are on top wing only. The average length is 22 ft. 6 inches and height is 7 ft. Total weight of machine empty is 730 lb., but on one of its test flights it carried a 210 pound passenger, a 140 pound pilot, 20 gallons of gas and six quarts of oil, and climbed to 5,000 ft. in 15 minutes.

The machine is designed for passenger carrying and instruction work as the passenger sits along side of the pilot and can actually converse during flight with throttle wide open. The dual controls are simple, easily operated by either pilot or passenger.

On the flight, it was noticed that the two control sticks were placed in their sockets without any permanent fastening, but fitting snugly, so that in case it was desired to carry passengers, mail or parcels one or the other could be removed giving more available space. Fortunately, on the first test flight both sticks were left in and after taking off and in the air 30 ft. the control stick pulled out and the machine flew uncontrolled until the pilot realized that he was holding a useless control stick. He grabbed the control socket with his free right hand, before it occurred that another stick was some distance to his left. The machine could not be controlled from the socket as the leverage was not great enough so he dropped the useless stick that was in his left hand and took the other control stick and with his right hand, throttled down his engine and in a few seconds brought the machine safely to the ground controlling it from an offset position.

The control sticks were then permanently secured in their sockets and another successful flight was made. The machine took off within 150 ft. and a landing was made with a roll of 80 ft. after the wheel touched the ground. The Lawrance 3-cylinder air cooled engine functioned perfectly at 1800 r.p.m.

In three succeeding days ten flights were made and seven passengers carried without any alteration to the machine.

Detroit Aviation Field News

Directors of the Aviation Country club at the last meeting, decided to keep the club house and the aviation field at Green Lake open all winter.

"Our aviators tell us and from personal experience, I can subscribe to the statement that there is no more beautiful country in the world to fly over," asserts E. Leroy Pelletier, chairman of the A. C. C.'s publicity committee. "What appears on the map as a series of beautiful hills with the valleys occupied by lakes, appears from an airplane as one big body of water dotted with a myriad of islands.

"Other country clubs close the cafe and sleeping rooms October 1, but this is the most beautiful time of the whole year in the Bloomfield hills and Oakland lakes region and as a result, the last two week-ends have been the biggest the club has ever known.

"More than 500 persons were at the field on Sunday. One who has not spent the autumn and winter months in this region can scarcely appreciate its beauty," continued Mr. Pelletier. "The club grounds and property on Green Lake is 700 feet higher than Detroit, with the result that the climate is always 10 deg. or so colder, much drier and the foliage on the oaks, walnuts, maples and other hardwood trees indigenous to that section, is now a blaze of color.

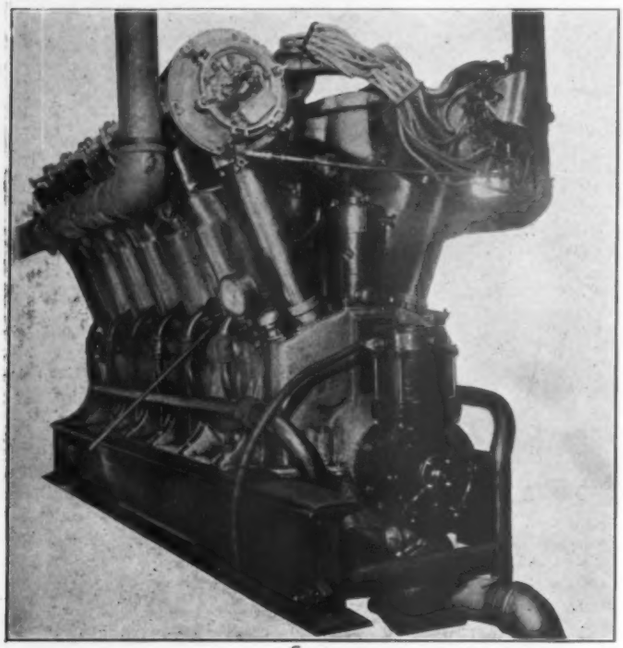
"We are planning for all kinds of winter sports as well as aviation. These besides the usual skating and skiing will include tobogganning, ice boating, fishing through the ice, hockey and other winter diversions.

"Sleigh-riding parties will be organized at times when conditions are suitable and some of our members already are at work on scotter sleds which will be driven by airplane engines and propellers.

"There has been more flying at the club in the past few weeks than there was earlier in the summer and there is no reason why this should not continue right through the winter as well."

Ignition End Airplane Starter

Among the refinements to aeronautical power plants which have been originated and developed by American genius, is the electric starter which enables the engines of an airplane or airship to be started as readily as an automobile motor. After a number of years of research and development in this field, the Bijur Motor Appliance Company, Hoboken, N. J., has placed on the market an electric starter which has a number of unique features. This unit differs considerably in design from aeronautical starters* hitherto manufactured by the Bijur company. The principle of a starter pinion which automatically engages with the rotating parts of the engine, during the time of starting only, is retained. The exposed propeller hub gear ring is eliminated, however, and the whole mechanism is contained in one compact, fully enclosed unit, which is bolted directly to a crankcase flange at the non-driving end of the crankshaft, where it adds only five inches to the total length of the power plant.



BIJUR IGNITION END STARTER ON A LIBERTY 12

Designed particularly to meet the requirements of the Liberty-12, this starter is adapted for use on a number of other leading engines. Provision for its attachment permits its being readily mounted on such aeronautical power plants as the Curtis C-12, the Packard, the Thomas-Morse and other engines. Although manufactured with only one type of mounting flange, this starter may be had in either clockwise or anti-clockwise rotations, and for mounting with the electric motor located vertically either above or below the crankshaft center line.

The features of this starter particularly emphasized are performance, safety devices, lightweight, compactness and ease and certainty of installation. The source of power is a 4 in. dia. 12-volt series electric motor which cranks the engine through a bevel gear and planetary reduction of 115 to 1 on the crankshaft. On the Liberty-12, the cranking speed is 40 to 50 r.p.m. with a current consumption of 110 to 150 amperes varying according to the stiffness of the engine and the condition of the battery.

The Bijur automatic shifting mechanism is employed, and the starter is connected to the crankshaft during the time of starting only. When the starting switch is depressed, permitting current to flow from battery to starter, the splined starter screw shaft moves longitudinally into mesh with splines cut internally in the hollow end of the crankshaft. This disengages automatically as soon as the engine begins firing.

Special provision is made to disengage the starter pinion in case of a backfire while cranking without damage to either starter or engine. By applying a wrench, brace or crank handle to the nut protruding from the back of the starter housing, the apparatus becomes a hand starter with a reduction of 20 to 1, with both automatic engagement and safety devices functioning.

Special attention has been given to obtaining minimum weight and small size without sacrifice of strength or performance. The machanism weighs slightly less than 30 lb. and adds only 5 in. to the length of the engine when installed.

Being mounted on the engine crankcase by means of a flanged mount, which is held by five studs, no shimming or adjusting is necessary. This insures that when once installed the starter will stay put, eliminating all possibility of misalignment trouble. Being fully enclosed the unit is not affected by oil, water or dirt.

* The original Bijur electric airplane starter was described in AVIATION AND AERONAUTICAL ENGINEERING, Feb. 1, 1919.

A New Tail Skid for the Curtiss Oriole

The Sierra Aircraft Co. of Pasadena in following its policy of "Flying service with the best and newest of equipment" has had a new type of tail skid and mounting placed on its Curtiss Oriole.

This tail skid is mounted with its support and swivel bearing outside the fuselage while the shock absorber cord is attached and remains inside the body. The machine, in test, does not show any decrease in speed due to this external mounting. The body has been reinforced to take this new mounting and properly distribute the load and strains throughout the body shell.

When the shock absorber cord has absorbed a load of eight times the static load any remaining over-load in bad landings is transmitted and evenly distributed to the entire body shell through the skid's vertical support. The tail skid is free swivel, non-recoil and so shaped that through failure of any part such as shock absorber cord, front or rear end of the skid, it will act as a sled runner and will evenly distribute the load to the body shell. In event of the breaking of the shock absorber cord the bottom of the fuselage will not be broken or damaged. This new tail skid allows the machine to be taxied readily without straining the body. It also gives the machine the proper resilience in landing that is required to make the plane feel as if it were well sprung.

An alloy shoe weighing approximately three pounds is used on this skid and will outlive one hundred hours of flying where short flights are made.

This new creation for the Curtiss "Oriole" has been given an exhaustive test by Lieut. Peyton Gibson, chief test pilot of the Sierra Aircraft Co., Pasadena, Cal., and he states he would not consider flying an Oriole on cross country work without its being so equipped.

This skid was designed by G. Edw. Barnhart and constructed by L. G. Stern, both of whom are with C. Robert Little of 44 W. Green St., Pasadena, Cal.

Second Parachute Saves Jumper

The Engineering Division of the Air Service has been conducting an engineering school at McCook Field for the past ten months. A number of field officers of the Air Service have been attending this school. The final exercises at the close of school consisted in taking the entire class aloft two at a time and letting them have the thrill of a parchute jump. The Martin Bomber was the airplane employed as the commencement rostrum, and the "speeches" were all delivered (although unheard) from an elevation of 2500 feet. Graduating or rather catapulting the class in this way consumed practically the entire day. Toward the end of the day Colonel Benedict was one of a pair taken up, and like the insomnia stories sometimes heard, stepped off the wing of the airplane at the proper signal into space. Space and lots of it, for when Colonel Benedict essayed to look about a bit he discovered that unlike Halley's comet, he had no tail, and that his team mate was not in his class at all for speed. Colonel Benedict's chute had not opened. Sensing the rapid approach of the Miami River he quickly pulled the second parachute and approached China more in accordance with the printed directions and negotiated the last 500 feet in ease and undoubtedly greater comfort.

Aerial Photography a Growing Industry

As happened in the practical application of many other valuable inventions, aerial photography, which had remained dormant, though quite well known for so many years, waited but for the war to come into its own. Needing but the occasion to give it power and purpose, it sprang into sudden and conspicuous usefulness, and now, with the ever-increasing development of the airplane, its logical and closely related industry, aerial photography extends itself inevitably into broader channels.

As far away as 1858, attempts were made by Goddard and Nadar in Paris to take pictures of the earth from the air, but so unsatisfactory was the experiment that no effort at repeating it is of record till in 1882 when Shadbolt, an Englishman, took several quite distinct views of London from a balloon. It was the airplane, however, that gave the art of photography its wings thereby establishing the position of aerial photography in industry, the arts and sciences.

From the beginning of the war, all of the belligerents recognized the value of the aerial camera, and, throughout the conflict, utilized it for an increasing number of purposes. Its work in spotting masked batteries, in recording the results of artillery fire, in locating the movements of troops and supplies no less than the lay of the terrain over which a particular engagement was taking place, the roadways, watercourses, bridges, mountains, hills, valleys and so on, and the pictures and mosaics prepared were invaluable at military headquarters and to the Intelligence Department. So expert did the photographer become and so efficient the service, that, within forty-five minutes from the time an order was issued, the camera man could ascend, shoot the picture, drop down to his field laboratory, develop the film and deliver the finished photograph. The photo-lorry, with its perfectly appointed laboratory, became a necessary part of field equipment and aerial photographs constituted a considerable part of its output.

Aside from its technical use in miltary operations, the aerial films flashed on our motion-picture screens from day to day while the war lasted did their very material bit toward informing us of movements on the other side, and more especially, in keeping us in touch with the boys in whom our interest centered. They gave us current history made visible in a new and striking way, thus quickening the perception and impressing the memory.

The high school pupil will study the history of the war with keener zest because it has all been visualized for him from a new and original angle by the aerial photographer, while the student of geography will find the dull pages of his textbook grown suddenly exciting and wonderfully illuminating by the addition of the airman's mosaics. It will bring about the apothesis, so to speak, of a dry subject, this geography with "pep" in it, a wonderful picture-puzzle with a thrill.

The adaptability of the aerial photograph to such enterprises as surveying, geodesy, catography and meteorology is self-evident, and an increasing demand from these sources is being made upon the War Department for copies of the photographic mosaics that it is constantly making through the Air Service.

Necessarily the question of the character and quality of the camera used in aerial photography are most important ones. Throughout the war, the great difficulty was in securing suitable lenses, the best obtainable being those captured from the enemy. The British aerial photo work was practically all done with their standard R.F.C. camera which was fastened beneath the machine and operated by a lever at the pilot's side. By a quite well devised system of springs and levers the plates were changed and stored.

American cameras, however, far outshone, in brilliance both in design and performance, anything produced by the Allies. These cameras were completely automatic, were run by electric motors, and took as high as a hundred exposures at one loading on film of practically 8 x 10 inch size. The simplicity of the American aerial camera is marked, although it functions perfectly and produces results that more than favorably compare with foreign competition.

Today there is available a vast amount of aerial photographic experience, data, records, and apparatus ready to go to work for commerce. There is no business or industry that does not have an adaptation for aerial photography.

Rohlfs Returns Praising French

Roland Rohlfs, one of the American fliers in the Gordon Bennett races held in France recently, has returned from France. He was slightly injured when the Curtiss-Cox entry, the Texas Wildcat, which he was flying from the test field at Villa Coublay to the starting field at Etampes, on the day before the race, struck rough ground and turned turtle. Rohlfs sustained a broken shoulder but expects to be flying again within a short time.

He had nothing but praise for the French and declares that the only possible cause for complaint was the failure of the French Aero Club to acquaint the American entrants of the true condition of the Etampes field.

"The Etampes field was, perhaps, the best that was available," said Rohlfs. "The trouble was that we were led to believe that France abounded with perfect flying fields and therefore designed our machines to operate under perfect conditions. The fields were not perfect. In fact, they were not as good as some of our own Long Island fields. There is absolutely no foundation for belief that the French selected a field which would be advantageous to their entries.

"France was not ready for such a race and there was little interest in it. I don't believe they had any idea that the American machines would develop the speed they did and as a result no advance efforts were made to level the fields to accommodate that speed. The main difficulty was that we did not have sufficient time after we arrived in France to adjust our machines to the conditions we found there. When we found what the conditions were we tried to meet them but the time was too short. The French gave us every possible assistance and the French fliers were extremely friendly.

"The French fliers, too, knew the course like a book. They made no special effort so far as real speed was concerned. Sadi Lacointe, the winner, flew his machine constantly before the race without any fear of damaging it. During the race, he flew at an alarmingly low altitude—at times his wheels were only two feet off the ground. Lacointe, by the way, is a wonderful pilot and his victory was both popular and deserving.

"We would naturally have liked to see the American entries win and the American entries were by all odds the fastest. In my flight over to Etampes, I flew throttled and got 150 miles per hour out of my machine and I had at least 40 miles per hour in reserve."

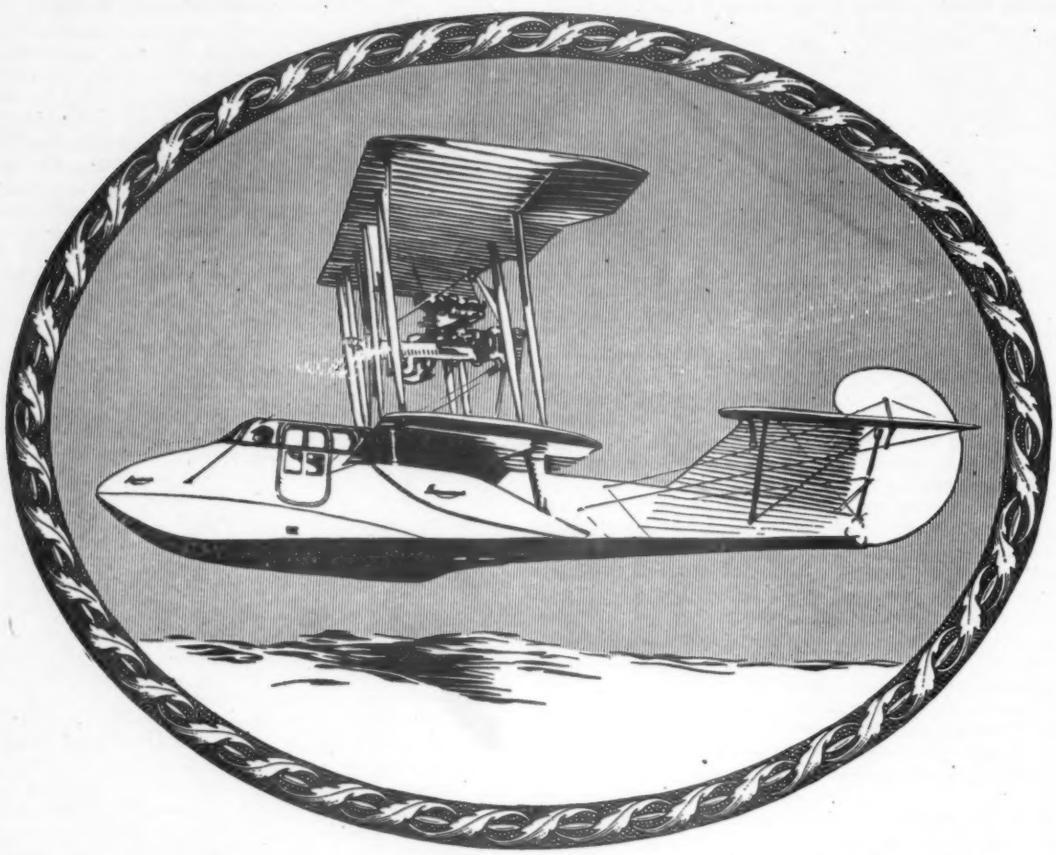
King's Airplane Garage

All early aviators will remember Charles King expert aviation mechanic and guardian of many noted pilots and ships from 1910 on. In the old days of exhibition work King was the assistant and mechanic of two well known fliers, Lester Holt in 1911 and 1912 and Allen S. Adams in 1912 and 1913, both of whom lost their lives in Government testing work during the war. King was the first civilian mechanic to join the 1st Aero Squadron, N. Y. N. G., when it was organized at Mineola, L. I., under Captain Raynal C. Bolling in 1916. Then John Hays Hammond's government experiments with wireless control of torpedoes from airplanes called and King responded and for the better part of a year he maintained the airplanes which were engaged in this work.

Always on the lookout for something new in aviation, King was one of the first mechanics to join up with the Air Mail Service. As chief mechanic at the Belmont Park terminus of the air mail lines, King was responsible for keeping the ships in commission and his contribution to the initial success of the service was a large one.

Commercial Aviation next interested him, and we find him as chief mechanic of the Traymore Aerial Tours of the Traymore Hotel, Atlantic City, N. J., during the summer of 1919. Last winter King, Bob Shank and Bill Jenkins toured all the Southern states with 3 planes carrying passengers and introduced flying to numerous communities in Virginia, North Carolina, Georgia, Tennessee, Kentucky, Illinois and West Virginia.

King is now starting an "airplane garage," the first of its kind in western New York. He will deal in gas, oil, etc., repair ships and overhaul engines—a real service station for the air tourist. His motto is "Drop in on us anytime—everyone welcome." Charles King is a super-trouble shooter and maintenance expert and he deserves all the success which experience and exceptional ability usually bring.



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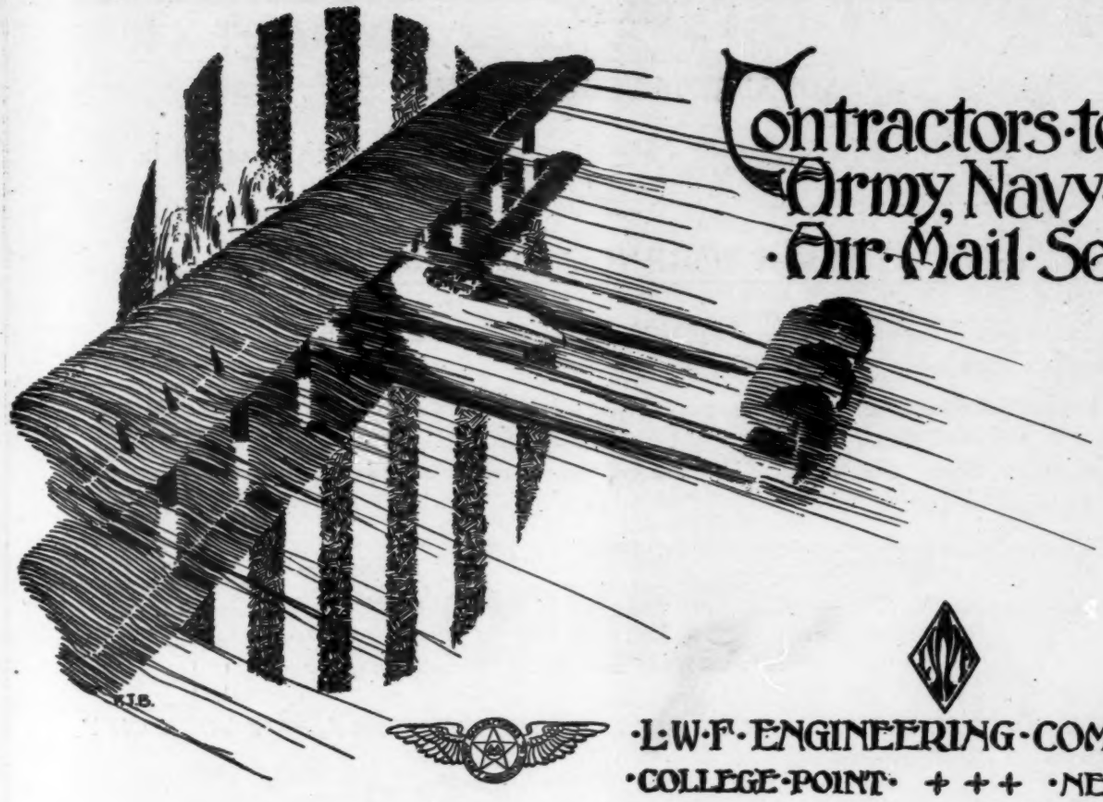

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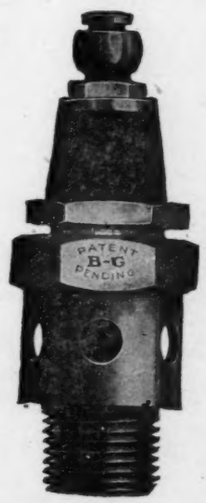

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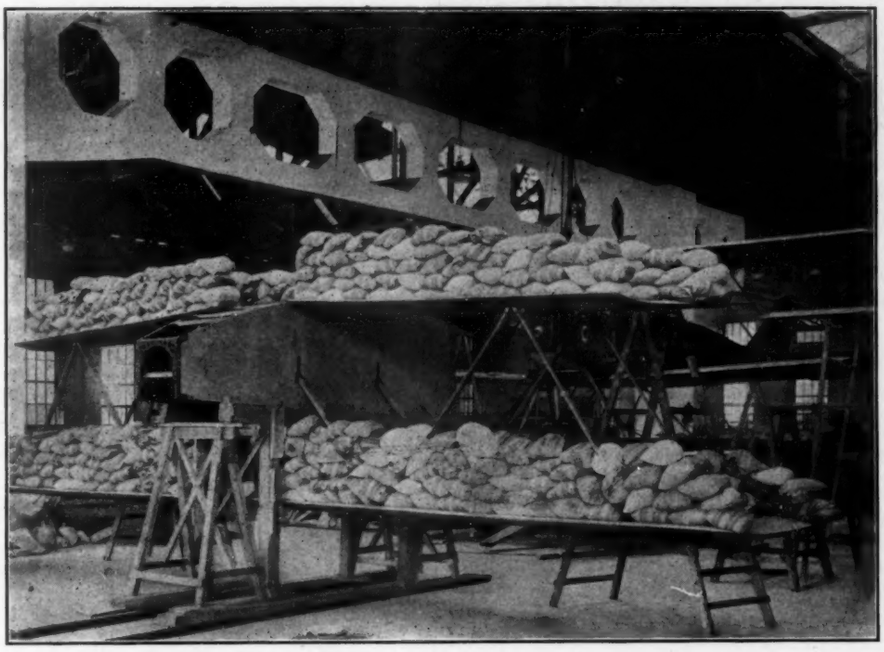

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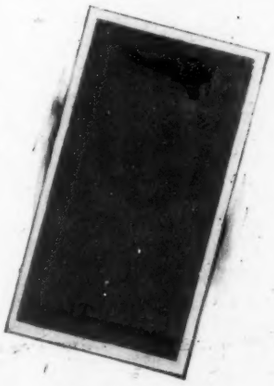

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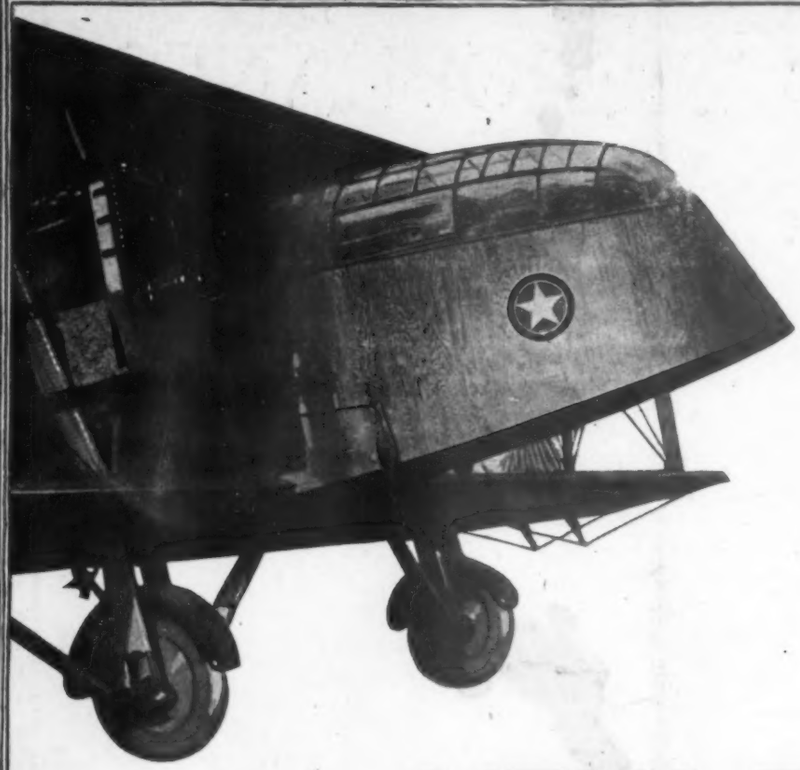

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